AMERICAN MACHINIST

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ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

Prentice 50-Inch Swing Upright Drill.

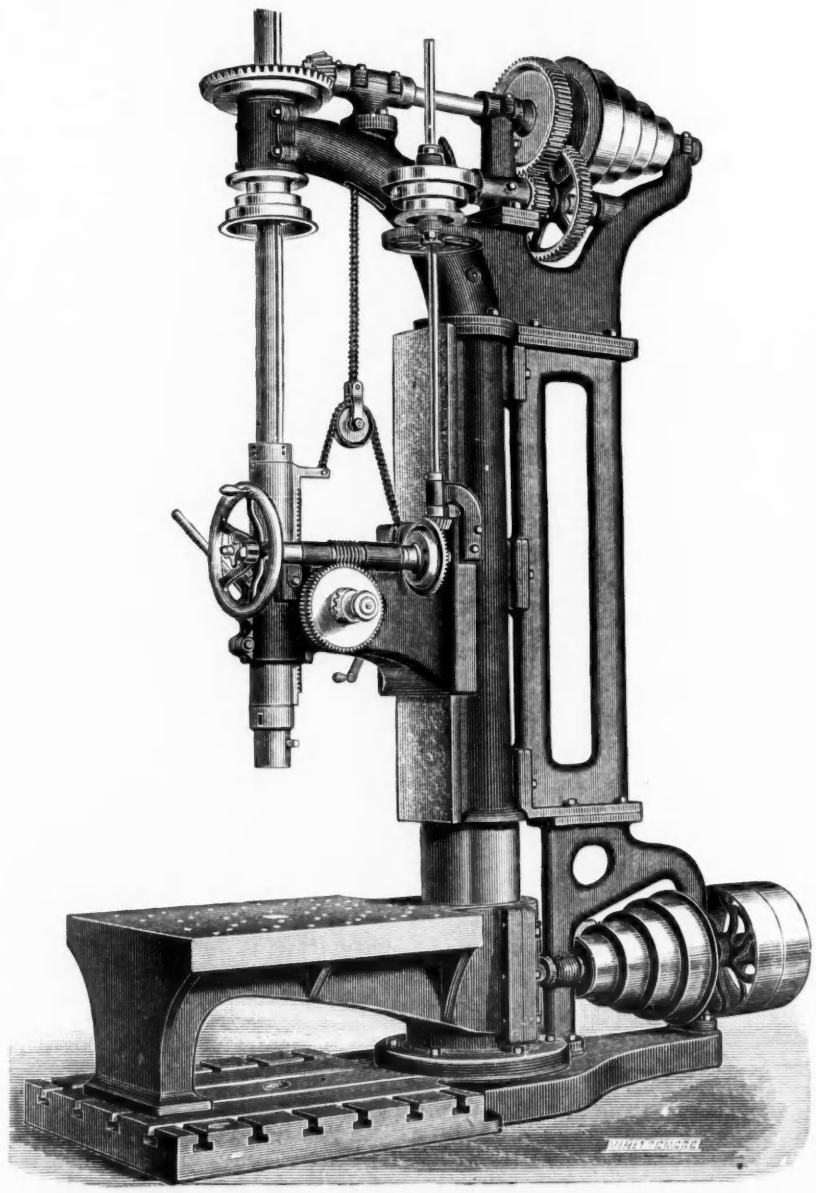
The cut on this page represents a 50-inch swing upright drill intended for heavy bridge and locomotive work, the parts being proportioned with the view of securing strength and rigidity, while ample bearing surfaces, well finished, provide for durability. Much attention has been devoted to making the drill convenient to operate. It has a rack and pinion and wheel on side, for raising and lowering the head on slide. The spindle shafts and studs are made of steel, selected as specially adapted for the purpose. The head and spindle are counterbalanced by one chain weight, thus enabling the operator to loosen either or both at the same time without danger of falling. A quick return movement is provided; and by means of an adjustable lever the spindle can be instantly moved to any point within its range. The head is raised and lowered on the column by a screw running vertically on the side, with nut and gear attached, and by means of a crank it is easily adjusted to any position on the column. The table is oblong, and extends directly from the column to the front, making a large and perfectly level surface to place work upon. It is supported by a pedestal with a broad foot resting on the base plate. The table swings on the column, and is provided with a taper pin to bring it central with the spindle. The base plate is planed perfectly level, and is provided with T slots to fasten work upon. The pinion bevel gears which connect with either the spindle or feed rod are made of steel, likewise all shafts, studs, and clutches. The feed cones have three changes, carrying 1½-inch belt. To make greater change in feed, the spur gear on feed cone can be removed and larger or smaller gears put on to obtain the speed required. This machine is made by Prentice Bros., Worcester, Mass.

To Keep Railroad Cars Cool.

The French railway authorities are engaged in a series of experiments for the purpose of finding out the best means of keeping railway cars cool. Our railroad companies might, with advantage to the public, devote some attention to the same subject. If our railroad companies showed any desire to adopt means for keeping cars cool our inventors would soon supply the apparatus. In France travelers are packed very tight, and most trains go very slowly, and the authorities have to arrange to deliver their human cargoes at distant termini with vitality not quite extinct. So they are now exercised in seeking how to cool their carriages. They have gone as far as India for suggestions, and the favorite experiment is with a kind of punkah. A long cylinder runs the length of the roof of the carriage, furnished with fans, set in motion by revolving the cylinder. After many systems tried, this seems to be the most practicable, and the only point in dispute is how to get the motive force. The surplus steam of the engine has been tried on one line, and on another a little arrangement like a windmill attached to each carriage, the motion of the train causing the wings to revolve, while the occupants of each carriage can regulate or arrest the stream of air. Both systems are being tested, and our companies need only take the benefit of these experiments and adopt the most successful or the least costly.

How A Locomotive Boiler Exploded.

In a paper read before the Engineers' Society of Western Pennsylvania, L. C. Burwell gives interesting particulars about the locomotive boiler which exploded last March, when the engine was running the Chicago limited express. The boiler was built at the Allegheny shops, Pittsburgh, and put to work in the beginning of 1880. Some time after, a crack developed in the angle of the throat sheet in the same place on both sides of the boiler. These were repaired by putting copper plates over the cracks, fastened with screw rivets. The rupture which caused the explosion originated at this throat-sheet crack on the right hand side, and it extended from there into the seam joining the wagon top to the barrel of the boiler. The rupture also ran down into the fire-box leg, making the whole length of opening about twenty-eight inches, and opening to a width of six inches. This had the effect of stripping four stay-bolts in the side of the fire-box immediately adjoining the rupture, and resulted in stripping or breaking every stay-bolt in the right hand side of the fire-box. Thus freed from its fastenings, the right side of the fire-box was thrown violently against the left, carrying with it part of the tube sheet and doubling down the crown sheet. At the same time, the force of the explosion tore up the track and lifted the rear end of the locomotive, turning it completely around, throwing the engineer and fireman high into the air and forward of the train, killing them instantly.



PRENTICE 50-INCH SWING UPRIGHT DRILL.

A recent number of the U. S. Patent Office *Official Gazette* contains particulars of a patented device called a "combined perambulator for teaching children to walk, and automatic seat therefor." The machine is very ingenious. It is a frame which is carried on wheels and has mechanism for catching a child when it begins to tumble in its feeble first attempts at walking. The inventor is evidently an ingenious person, but he lacks discriminating insight into human nature. If he had got out a machine where the mother could walk along and grab up the infant when its unskilled steps stumbled, so that she could then and there pour out the unintelligible expressions of fondness and encouragement, usual on such occasions, his apparatus might have had a chance of becoming popular. But to make a machine where an inanimate seat thrust automatically under the child gets all the fondling to do and is protected in its loveless task by a wooden frame that keeps mothers arms away, is to court the aversion of those who are regarded as possible patrons.

Danger in Hollow Pistons.

Since the publication, in our issue of May 17, of a communication detailing the particulars of an explosion in a hollow pump plunger, we have received a large number of letters describing explosions in "all sorts and conditions" of hollow plungers and pistons used for both steam and water. The number of these letters, and the fact that they differ but little except in unimportant particulars, make their publication unadvisable. We have, since the appearance of the communication first referred to, published other communications, explaining, so far as we know, the cause of such explosions, to which we refer several inquirers. In some instances, the letters referred to show that very serious accidents have resulted from explosions in hollow pistons, in one instance a machinist being injured so as to incapacitate him from following his trade in the future. The moral seems to be to avoid exposing hollow pistons that have been in use for some time to the heat of a fire, at least until the inside has been exposed to the atmosphere for a considerable time, and in removing plugs from, or in drilling holes into, such pistons, do not bring a lighted lamp in close contact with the hole.

Domeless Locomotives.

To the few American engineers who advocate the use of domeless locomotives, the recent action of a leading English railway may offer good food for reflection. On the Great Western Railway, which is the old Brand wide-gauge railway, domeless locomotives have received more application than on any other railway in the world. If ever that form of boiler would give satisfaction it would be on a road of that kind, where there was ample room to build large boilers and wide fire boxes. Every resort which skill and ingenuity could devise was resorted to for the purpose of making these domeless boilers efficient, but the efforts were futile. The domeless boilers never gave entire satisfaction, and now the company have decided to abandon them altogether, and all new locomotives will have domes. The domeless locomotives on the Boston and Albany Railroad do not lead those who have had anything to do with them to believe that this style of engines has any successful future in American railroad practice.

Glass Bearings.

A correspondent, writing from the motive power and machinery department of the Chicago and Northwestern Railway, Chicago, argues in favor of using glass bearings for locomotives. Since glass has been successfully used in the bearings of watch-works he cannot see why the cheapness and hardness of glass do not commend that substance to master mechanics as an admirable substitute in many places for iron and brass. He contends that glass is less "frictional" than metal, therefore it is better adapted for bear

ings, and will run with less expenditure of power.

The conditions of service are so different in the cases of the bearings of a watch and those of a locomotive that a substance which gives the best results in the former may be utterly worthless in the latter. Glass has been tried repeatedly in various parts of the locomotive, as a substitute for metal alloys, but the result has not been such as to encourage extending the practice. As gibs for guides, this material has done fairly well where it was properly attended to, but it goes to pieces so readily when anything goes wrong that few master mechanics care to run the risk attending its use.

An Improved Draft Gauge for Chimneys.

We are indebted to the Hartford Steam Boiler Insurance Company for the use of the accompanying cut of draft gauge for chimneys and the description, which appear in May number of the *Locomotive*, published by that company:

"The influence of the chimney upon the working and economy of a steam-power plant is a factor of the greatest importance, and is one which, in too many instances, does not receive, in its design, location and execution the consideration which should be given to it.

"The function of a chimney is, primarily, to furnish sufficient draft to properly burn the fuel; secondly, to carry off the products of combustion. If the chimney is so constructed that the first of the above-named conditions is *properly* fulfilled, the second will, in general, follow as a natural consequence.

"In designing a chimney for any given boiler plant, due regard should be paid to its location with regard to the surrounding buildings or adjacent hills, if there are any, the general direction of the prevailing winds, etc., as all these conditions have a direct and often very great influence upon the proper working of the chimney. The chimney should be well constructed, the foundation should be firm enough to prevent any unequal settling which would be liable to crack the walls, the bricks should be carefully laid, care should be exercised that no air-holes exist in the shaft of the chimney or the flue leading to it. The chimney, if of considerable size, should be built with double walls; the inner stack or core should be entirely independent of the outer one. This construction serves two important purposes: it prevents undue loss of heat by radiation, and prevents the excessive, unequal expansion and contraction of the outer stack, which might occur if it were a single shaft exposed on the inside to the heat of the escaping gases, and on the outside to the atmospheric temperature, the difference of which in some cases is as great as 600° F. This adds greatly to the very important element of the strength and durability of the outer shell of the chimney.

"The cause of the draft power of a chimney may best be illustrated by assuming a particular case and following its working. Let us suppose we have a chimney 100 feet high from the top of the grate bars, the point from which the height of a chimney should always be reckoned. Suppose the temperature of the external air is 60° F., the temperature at the bottom of the chimney, 400° F., which is about right in a well-arranged plant, and the barometer stands at 29.92 inches.

"Then it is evident that we shall have in the chimney a column of the hot gases, the temperature of which is 400° Fahr., and the height 100 feet. The density or weight per cubic foot of these gases, when 24 pounds of air are supplied to each pound of coal burned, will be about .0482 pounds, while the density of the external air will be about .0764 pounds per cubic foot. Now, it is plain that in this case the pressure of a column of the atmospheric air 100 feet high will be 7.64 pounds per square foot, while the pressure of a similar column of the chimney gases would be but 4.82 pounds. Now, as the pressure of that portion of the atmosphere above the chimney-top is evidently the same on the top of the column of hot gases as it is on the surrounding air at the same height, it may be neglected, and we need consider only the gases for the given height of chimney and the same height of the external air. Now, in the case we are considering, the difference in the weights of the column of atmospheric air at 60°, and the chimney gases at 400°, is for a height of 100 feet 7.64−4.82= 2.82 pounds per square foot, and it is this excess of pressure of the external air over that in the chimney which causes it to flow into the chimney through every opening into it. In properly-arranged boiler furnaces the only available opening is, of course, through the layer of incandescent fuel on the grate: in its passage through the fuel all the incoming air is heated and forced upward in its turn, and thus the process goes on continuously.

"Now, it is evident that, if we can measure this unbalanced pressure in the chimney, we have a means of determining whether the chimney is 'drawing' as well as its height should indicate, and if it is not, it may aid us in discovering where the fault lies, and so remedy it.

"This the instrument shown herewith enables us to do with very great accuracy.

"It has been designed and made by this company, who felt the need of something for their own use, which would give more accurate and reliable results than the crude siphon gauges heretofore used. We are not aware that anything at all approaching it, in accuracy or completeness, has ever been made or used for this purpose.

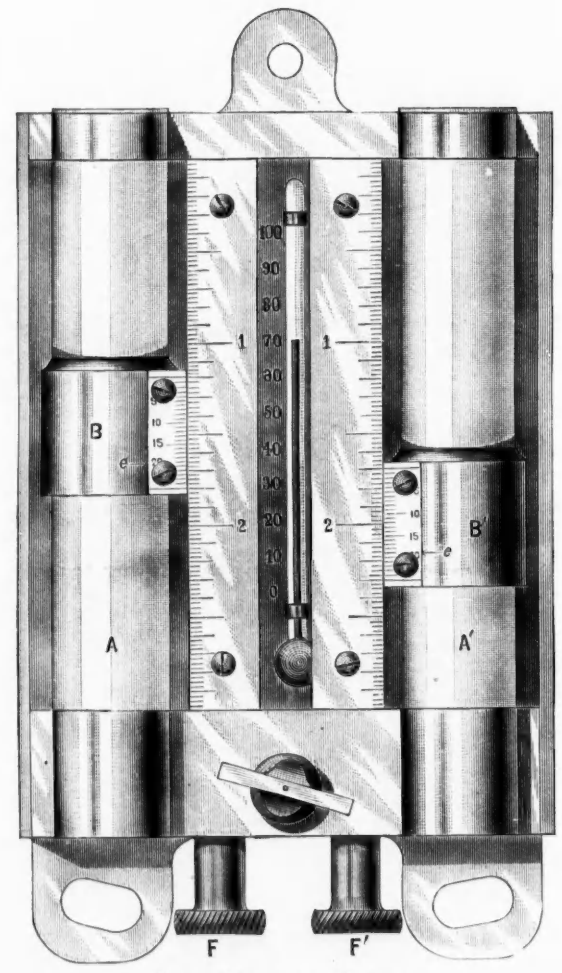
"The cut shows the instrument full size. A and A′ are glass tubes suitably mounted, as shown, and communicating with each other by means of a passage through the base, which passage may be closed by means of the stop-cock shown. Surrounding the glass tubes are the two brass rings B and B′. These rings are attached to blocks which slide in dovetailed grooves in the body of the instrument, back of the three-inch scales, and may be easily moved up and down by screws, the milled heads of which are shown at F, F′. The three-inch scales are divided into fortieths of an inch, and read to thousandths of an inch by the verniers *e* and *e′*, which are attached to the sliding rings B, B′. This arrangement of scale and vernier is exactly the same as that of the ordinary Brown & Sharpe vernier caliper, with which every machinist is familiar, and is so adjusted that when the instrument is perpendicular, and the tops of the brass rings B and B′ are at exactly the same height, the reading of each is precisely the same. This being the case, it is evident that if the two short rings are set at different heights, as shown in the figure, the difference in their readings will give the difference of level between them. The thermometer shown in the center of the instrument is for the purpose of noting the temperature of the external air at the time of making observations, without the trouble of taking along an extra thermometer. The method of using the instrument is as follows:

"At any convenient point, as near the base of the chimney as possible, a hole is made large enough to insert a thermometer to ascertain the temperature of the chimney. (This is something that it is extremely important to know, for other reasons than those connected with the use of the above instrument, and facilities for so doing *should always be provided* when a chimney is built.) The most available place is generally in the main flue leading from the boilers to chimney, and about twelve inches from the side of the chimney. The height from this opening to the top of chimney, and also to top of grates, should be noted for reference.

"The chimney gauge is then attached to some convenient wall by means of small screws, the holes for which are shown in the cut. The tubes are then filled about half full of water, when the verniers afford an easy means of setting it exactly perpendicular. One end of a flexible rubber tube is then inserted into the upper end of one of the glass tubes (which are both open at the upper end) and the other end of the tube is inserted in the chimney flue. Then it is evident that the surface of the water in one of the tubes is open to the atmosphere, and that in the opposite tube is in communication with the somewhat lesser pressure of the hot gases in the chimney, and consequently the water in the tube communicating with the chimney will *rise* to an amount dependent upon the difference of pressure inside and outside of the chimney. The tubes B, B′ are then adjusted by means of the screws F, F′, until their upper ends are just tangent to the surface of the water in the two tubes. As the surface assumes a curved form in consequence of the capillary action of the sides of the tubes, this may be done with very great accuracy. The reading of the two scales is then taken, and their difference gives the height to which the water has risen. At the same time the temperature of the flue is noted, as well as that of the external atmosphere. Comparison may then be made with the following table, which has been computed by us for use in connection with investigations of chimney draft. The calculations have been made for a chimney 100 feet high, with various temperatures outside and inside of the flue, and on the supposition that the *temperature of the chimney is uniform from top to bottom*. This is the basis on which all calculations respecting the draft-power of chimneys have been made by Rankine and all other writers, so far as we know, but it is *very far from the truth* in most cases. The difference will be quickly shown by comparing the reading of the above-described gauge with the table given. For other heights than 100 feet, the theoretical height is very easily found by simple proportion, thus: suppose the external temperature is 60°, temperature of flue 380°, height of chimney 137 feet, then under 60° at the top of the table, and opposite to 380° in the left hand margin, we find .52″.

"Then 100 : 137 :: .52″ : .71″, which is the required height for a 137-foot chimney, and similarly for any other height.

"Some interesting facts relative to the cooling of the gases in chimneys have been developed by us, of which we shall give an account in a month or two. For instance, in one



DRAFT GAUGE FOR CHIMNEY.

HEIGHT OF WATER COLUMN DUE TO UNBALANCED PRESSURE IN CHIMNEY 100 FEET HIGH.

Temperature in the Chimney.	TEMPERATURE OF THE EXTERNAL AIR—BAROMETER, 14.7.										
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
200	.453″	.419	.384	.353	.321	.292	.263	.234	.209	.182	.157
210	.470	.436	401	.371	338	.309	.280	251	.227	.200	.175
220	.488	.453	.419	.388	.355	.326	.298	.269	.244	.217	.192
230	.505	.470	.436	.405	.372	.344	.315	.286	.261	.234	.209
240	.520	488	.451	421	.388	.359	.330	.301	.276	.250	.225
250	.537	.503	.468	.438	.405	.376	.347	.319	.294	.267	.242
260	.555	.528	.484	.453	.420	.392	.363	.334	.309	.282	.257
270	.568	.534	.499	.468	.436	.407	.378	.349	.324	.298	.273
280	.584	.549	.515	.482	451	.422	.394	.365	340	.313	.288
290	.597	.563	.528	.497	.465	.436	.407	.379	.353	.326	.301
300	.611	.576	.541	.511	.478	.449	.420	.392	.367	.340	.315
310	.624	.589	.555	.524	492	463	.434	.405	.380	.353	.328
320	.637	.603	.568	.538	.505	.476	.447	419	.394	.367	.342
330	.651	.616	.582	.551	.518	.489	.461	.432	407	.380	.355
340	.662	.638	.593	.563	.530	501	.472	.443	.419	.392	.367
350	.676	.641	607	.576	.543	.514	486	.457	.432	405	.380
360	.687	.953	.618	.588	.555	.526	.497	.468	.444	.417	392
370	.699	.664	.630	.599	.566	.538	.509	.480	.455	.428	.403
380	710	.676	.641	.611	.578	.549	.520	.492	.467	.440	.415
390	.722	.687	.652	.622	.589	.561	.532	.503	.478	.451	426
400	.732	.697	.662	.632	.598	.570	.541	.513	488	.461	.436
410	.743	.708	.674	.643	.610	.583	.553	.524	499	.472	447
420	.753	718	.684	.653	620	591	.563	.534	.509	.482	457
430	.764	.730	.695	.664	.632	.602	.574	.545	.520	.493	.468
440	.774	.739	.705	.674	.641	.612	.584	555	.530	.503	.478
450	.783	.749	.714	.684	.651	.622	.593	564	.540	.513	.488
460	.793	.758	.724	.694	.660	.632	.603	.574	.549	.522	.497
470	.802	.768	.733	.703	.670	.641	.612	.584	.559	.532	.507
480	.810	.776	.741	.710	.678	.649	.620	.591	.566	.540	.515
490	.820	.785	.751	.720	.687	.659	.630	.601	.576	.549	524
500	.829	.791	.760	.730	.697	.669	.639	610	.586	.559	.534

chimney, 122 feet in height, we noted the following:

Temperature at the base.....320°
" " top.....230°

and the amount by which the height of water column in the gauge fell short of the theoretical, as given in the above table for uniform temperature, was accounted for to less than the thousandth of an inch.

"A Short Account of a Great Firm, with Some Thoughts on its Present Position and Future Prospect," is a short pamphlet sent us by G. T. Dickinson, Newcastle-Upon-Tyne, England. The writer speaks of Britain under cover of the "great firm," and he thinks that the trade policy of the country is wrong. He argues for protection or reciprocal trade relations with other countries. His arguments are well sustained, and his views are those of an active and growing minority of British thinkers.

The death of Thomas Lynch has recently taken place in Manchester, England, and although little noticed by the press or the people, this man formed an interesting link in the chain of steam engineering. He was for several years engineer in charge of the first steam engine ever used to propel machinery by direct action. There had been engines previously in use driving machinery, but they pumped water, which was used to drive a water-wheel which ran the machinery. About 1790 an engine was put up in Manchester to drive the machinery of a mill without the intervention of a water-wheel. This engine was in use up to the middle of this century, and Lynch was in charge of it for several years.

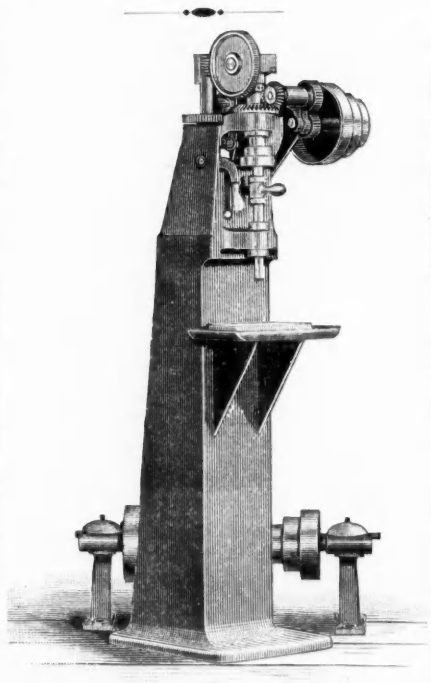
In the course of an address delivered at New York on Decoration Day, Gen. Butler made the following remarks on our National defenses:

Our Government is so strong and our Nation held so powerful, and so able to cope with any class of dangers that may threaten us either at home or abroad, that we sleep in peace and quiet, with our shores unguarded by a navy with a single effective ship; our harbors undefended by fortifications upon which are mounted a single gun that is not obsolete. * * * * *

I have said—and all my comrades in arms will agree—that armies may be improvised sufficient for all the needs of this country. They will assemble at call, like the clan of Roderick at the summons of the fiery cross. But not so with the navy. The sailors, indeed, would be ready if we do not succeed in crushing out our merchant marine. Years must pass before a navy can be built and armed sufficient to cope with any fifth-rate naval power in the world. Let us not deceive ourselves. For blockading purposes in our late war a navy was improvised with almost equal facility, but that was to be used against a combatant which had no cruiser which ever came into a home port. This can not be done again. In naval warfare all is changed. The guns which an armed ship must now carry to protect itself will take months in construction after the plant should be erected upon which they could be made. There is no civil requirement which needs the machinery or the erection of such a plant. Years are required to build a naval vessel of steel and iron to meet one of the heavy armed vessels of England, France, or Italy. An adequate navy ought to be made ready, because our only weak point of power on earth as a nation is the liability to be attacked by a naval force precipitated upon us, and our cities laid under contribution months before we can be ready with like force either to repel or attack in return.

High Speed Locomotives.

Discussing the practicability of constructing a locomotive that will be capable of maintaining a speed of sixty miles an hour the London *Engineer* says: "There are three different ways in which sufficient boiler power—say 1,500 horses—can be obtained on a narrow-gauge—4' 8½"—road. The first consists in so constructing the engine that the fire-box shall be nearly the full width of the machine. The second consists in altering the construction of the grade. The third in adopting mineral oil as a fuel, either in conjunction with coal or by itself. We put the wide fire-box scheme first, because experience acquired in the United States seems to indicate that the plan is perfectly feasible. Mr. Wootten has run his engines successfully at seventy-five miles an hour. Their driving wheels are only 5 feet 8 inches in diameter, and their grates are 9 feet long by 8 feet wide. The fire-box spreads far over trailing wheels on each side, and the center of gravity of the machine is very high, but this elevation of the center of gravity promotes steadiness and gets rid of the bumping, jerking motion of engines with low boilers and wheels. The true difficulty about the Wootten engine appears to be the excessive speed at which the reciprocating parts must move. A 5-foot 8-inch wheel, running at seventy-five miles an hour, makes nearly 366 revolutions per minute. With a piston stroke of 2 feet this means 1,464 feet of piston speed per minute. There is no objection to this high velocity; but there is a great deal to the fact that the piston, with all its appendages, as the cross-head, connecting-rod, etc., should have to be stopped and started 732 times in a minute. Even higher velocities of rotation are obtained by screw engines in torpedo boats, but difficulties are got over with them by making all the moving parts very light. Unfortunately the same thing cannot be done with locomotives. Mr. Wootten, however, manages to get his engines over the road at 75 miles an hour without accidents, and if he does this there is no reason why we should not be able to do the same with small wheels.



Automatic Drill Press.

The illustration presented herewith is that of a drill press, of somewhat novel construction, recently brought out by E. E. Garvin & Co., of 139 to 143 Centre Street, New York City.

Each head is a self-contained drill press, enabling the manufacturer to mount them side by side, on a single base or framework, in a line of two, three or four, as the character and variety of drilling may demand.

The feed is automatic, operating through a cone of three changes to a worm and gear, and thence through a pinion which propels the rack, stepped into top end of the spindle. A noticeable feature of this feed connection is the smooth, light running of the spindle—the result of a step instead of a shoulder contact—thereby avoiding a considerable amount of friction.

The spindle is evenly counterbalanced by weight hanging in column. The feed is automatically tripped, and by using a sufficiently heavy weight may be self-returning; when not so arranged, the spindle is returned by pushing up the handle shown in the front of the head. Shown to the left of this handle is the one to engage the automatic feed.

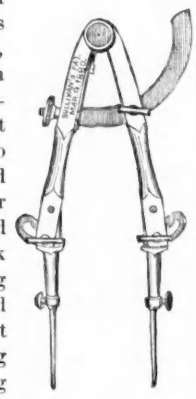
Each head is provided with an independent table, bolted to planed face of column, and adjustable up and down upon it. This arrangement is not shown in the cut.

A chuck with adjustable back jaw is designed to use especially with this press, fitted so as to receive odd-shaped jaws for special pieces, and is operated in the same manner as the ordinary milling machine vise with one screw.

Countershaft is single, but has independent movement for each tight pulley and cone, when two or more heads are used together, giving them each an individual action in regard to their driving gear.

Sullivan's Dividers.

The small engraving presented with this represents a new form of dividers, made by James Sullivan, Fitchburg, Mass. It will be seen that the points are separate pieces, and that they can be swung into position so as to stand vertical to the work, or that one leg may stand in line with the shank while the other is swung at an angle, when used on work of different heights, thus providing for each point standing vertical to the plane of the piece on which it is being used under all conditions of use. The length of the points is also adjustable in the sockets to accommodate irregular surfaces.



The divider points can, if desired, be removed and caliper legs substituted, which can be used, by turning, for either outside or inside calipers; or one caliper leg and one point can be used for lining up work; or one knife-edge can be used for cutting paper washers, etc.

The London *Ironmonger* says: "The locomotive engineering works in Glasgow and neighborhood have been enjoying a most prosperous run of business for a long time past. They have had large orders both for home and foreign railways. India and Australia have been excellent customers, and in reality they continue so. But in view of the general breakdown in trade, not merely here, but in America and the Continent, it now becomes a question whether this prosperity can be much longer maintained. Expectation at present is mainly directed towards Canada, where great extensions of railway are needed to open up the vast districts towards which so large a stream of emigration has been pouring within the last two or three years. The Government of the Dominion has been urged to foster railway extension, and some decision on the subject will be awaited here with scarcely less interest than in Canada itself."

Denver, Col., is to have another National Mining and Industrial Exposition this year. It will be held under the auspices of the Denver Chamber of Commerce. Much interest is manifested in the enterprise, and the exposition is to be larger than any other previously held.

With the number just to hand, our ever welcome contemporary, the *English Mechanic and World of Science*, reaches its one-thousandth number. As the paper has come out regularly once a week since the first number appeared, the journal has now reached an age of over nineteen years. During the time it has been in existence, the *English Mechanic* has witnessed many important changes in the mechanical world, and its influence has always been exerted in advocacy of sound scientific doctrines, so that the good effects due to its training would be hard to estimate.

In editorially noticing the thousandth mile stone of its existence, the paper, while regarding its past history with honest pride, anticipates works of usefulness in the future with which the past shall appear as the seed-corn in comparison with the full harvest.

President Sweet made a neat point in his reply to the welcoming address of the Engineers' Society of Western Pennsylvania in the way of contrasting the reception (or lack of reception), last year, of the American Society of Mechanical Engineers by the functionaries of West Point, with that accorded them by the engineers, manufacturers and mechanics of Pittsburgh. His comparison of the importance of the men who controlled the great manufacturing and engineering enterprises of the country, like those of Pittsburg, with the officials who looked after the destiny of West Point, was not flattering to the latter, and his allusion to the fact that in time of need the country always looked for assistance to such men as Captain Ericsson in their capacities of engineers, was received with applause for the veteran engineer.

Monster Steam Hammers.

The iron works at Le Creusot, France, where most of that nation's Government ordnance work is done, is famous for its array of steam hammers; not equaled in the world. There is one 100-ton hammer—long tons—with a fall over 16 feet; one 40-ton hammer has a fall of nearly 10 feet; one 15-ton hammer with a fall equal to the last; two 10-ton hammers with 6½ feet fall, and one 8-ton hammer with a fall of 6½ feet. The 100-ton hammer is the largest in the world. The foundations are composed of a mass of masonry, laid in cement, resting on bed-rock, which occurs at a depth of thirty-six feet, an anvil block of cast iron, and a filling in of oak timber, designed to diminish by its elasticity the vibrations resulting from the blows of the hammer. The masonry foundation presents a cube of over 21,000 cubic feet. Its upper surface is covered with a layer of oak nearly forty inches thick, placed horizontally, on which rests the anvil. The anvil block consists of six horizontal courses, each imbedded upon plane surfaces. Each course is formed of two castings, except the upper one, a single block which weighs 120 tons, and supports the anvil. The entire weight of the anvil is 720 tons. The steam cylinder which operates the hammer, which showers its blows upon this ponderous anvil, is 75½ inches diameter, with a stroke of 16 feet.

In ordinary working, the hammer delivers a blow of about 1,640 foot tons. The entire height of the hammer structure is 102 feet. Notwithstanding the enormous weight of the blows delivered, everything is so well proportioned that the shock produces but slight vibration.

Casting Steel Under Pressure.

The casting of steel under pressure is practiced extensively in the Whitworth Works, Manchester, England. The flask used for this operation is made of steel, and is built up of sections united by broad flanges, bolted together in such numbers as to accommodate the length of the ingot to be cast. All moulds are cylindrical in form. The interior of the flask is lined with square rods of wrought iron, longitudinally arranged, which form, when in place, a complete cylindrical interior surface. The casting is made directly into the mould from the top.

On the completion of the casting, the mould is moved to a position under the movable head of the press, which is allowed to descend until the tup is in contact with the metal of the mould. The first impress felt by the metal is due to the weight of the press head alone. This pressure is gradually increased from below by hydraulic action, until the pressure exerted amounts to six tons per square inch. This pressure is applied by the direct action of steam and pumping engines, and is indicated by a dial. When the maximum pressure is reached,

which takes about half an hour, the pump is stopped and a uniform pressure of about 1,500 pounds per square inch is established, by attaching an accumulator to the press and allowed to remain till the metal is sufficiently cooled to insure no farther contraction in the mould.

Construction of Bevel Gears.

BY ISAAC WHITEHEAD.

In principle and construction bevel gears do not differ materially from spur gears, the only difference being that a spur gear drives a shaft parallel to itself, while a bevel gear drives a shaft at any angle to itself, thus producing in effect the action of two cones rolling upon each other instead of two cylinders, as is the case with spur gears. To lay out the work, therefore, is the chief information necessary in addition to the instruction given in respect to spur gears.

All bevel gears are made in pairs, except when at an angle of 45°; then they are called miter gears, and one will pair with itself. When the shafts are not at right angles to each other, the gears are called skew bevel, but all are laid off on the same general principle.

For an example, we will proceed to lay down the working drawing of a pair of skew bevel gears, the two shafts lying at an angle of 60° to each other, and the proportions required being 3 to 1.

TO LAY DOWN THE WORKING DRAWING.

Lay down the lines $B\ A$ and $B\ C$, Fig. 1, at the angle of 60° to each other. In judging of the strength and proportions necessary for each case, the radius, pitch and width of face are now determined upon. For this case we will use $1\frac{1}{8}''$ pitch, 48 and 16 teeth respectively, of $3\frac{1}{2}''$ face. To obtain the pitch diameter for 48 teeth $1\frac{1}{8}''$ pitch, tables are made of factors, which are obtained by computing the true relation of the length of chord to length of the circumference between pitch points. If we took the formula $48 \times 1\frac{1}{8} \div 3.1416$, this would give us the arc pitch diameter; while $180° \div 48 = 3° 45'$, and then divide $1\frac{1}{8}''$ by the sine of 3° 45′, which is .0654, and the quotient will equal the chordal pitch diameter, $17.2'' = 8.6''$ radius 16 T., $1\frac{1}{8}$ P = sine of 16 = .195, therefore $1\frac{1}{8}'' \div .195 = 5.77''$ pitch diameter $= 2.883''$ radius. A able of factors produced from this base is enerally used as a shorter method than producing the sine.

Draw a line parallel to $A\ B$ and $8.6''$ within the angle of shaft, and another parallel to $B\ C$, $2.883''$, the lines intersecting each other at E. A line drawn from E to B will be the line of pitch. From E, on the pitch line, set off the width of face, $3\frac{1}{2}''$, to N. From the points E and N produce the lines $S\ R$ and $T\ P$, at right angles to the line of pitch $B\ E$, and cutting the lines of axis of the two wheels. From the center E lay off the depth and height of the tooth required for $1\frac{1}{8}''$ on both sides of the pitch line, and also the thickness of the rim, all upon the line $S\ R$, and produce each point to the center B, as the whole form of tooth and rim always radiate to one common center, B. To lay out the form of tooth required on the plane $S\ R$, that being the plane of working contact, take R as a center, with the pitch, root and point of teeth as radius, and describe arcs as shown at X. Upon a radial line, W, lay off a tooth the proportions and curves required for a spur gear of the pitch radius of $R\ E$. The same principle is applied to the pinion teeth. The principle of these curves, etc., I will treat in a future paper.

The hub and plate, or arms, are then laid out, and the working drawing is complete.

TO BUILD UP THE RIM.

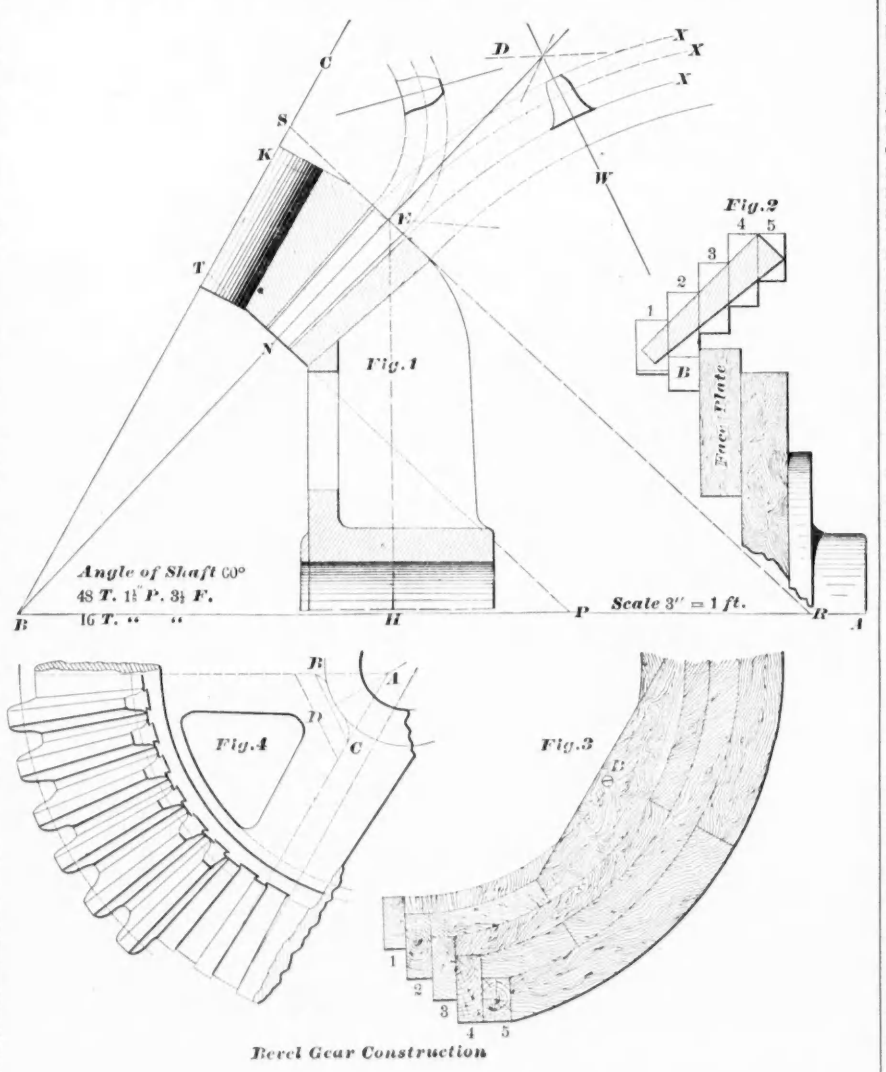
Fig. 3 is a portion of the built-up ring, No. 1 being the first layer, screwed to any face-plate of convenient size. A section of the rim is laid out, as in Fig 2, and the thickness of courses marked out as shown. Then the segments are sawn out to the various radiuses, and built up on the face-plate, as in the case of a spur gear. On one of the courses—in this case the second—it is a good plan to leave three segments (when there are six to the course and four when there are eight) straight on the inside, as shown at B, in Figs. 2 and 3. After it is built up, it can be taken off the face-plate, and re-screwed through these projections to a face-plate, as shown in Fig. 2, which contrivance enables it to be turned inside and out without re-chucking or turning it round on the face-plate, which is a very great advantage. It is, therefore, turned down to the size as shown in the section, leaving only the necessary connection at B, and the inside of the rim can be made perfectly straight across by paring through the ridge between the connections, and testing it with a small straight edge. The rim can be taken off after boring two or three dowel holes through the connections, if desirable, while the teeth are fitted into the ring, then returned to the lathe, finding its place from the dowel pins, exactly.

The same course is taken in getting out the teeth as described in the case of spur gears, especial care being taken to turn up the rim and teeth to the angles laid out in the drawing. The bevel that sets in the rest socket is also of advantage here. The teeth are laid off, first on the ends of the teeth on the outside diameter, at E, and then transferred with the bevel, drawing radial lines across the face on the points of the teeth, and so obtaining the spacing on the small end by but once spacing off, as in spur gears.

TO CONSTRUCT THE CENTER.

The arms are made by letting them into each other edgeways, as shown at A, Fig. 4. A good, practical way to form the hub is by angular pieces, as shown at A, B, C, the angles formed at B and C being obtuse with the arm and much of the nature of a hollowed corner, while it can be very readily made larger or smaller by loose pieces D, to suit any size of shaft. For a jobbing trade, and in a commercial view, this style may be preferable. The teeth are always cast down in the mould, therefore the sand between the arms must be lifted out separately after the wheel is rammed up and cope is lifted off. To enable the moulder to do this plates are made the shape of the spacing between the arms and ribs, and eye-bolts tapped or cast into the plates upon which the sand is rammed up and lifted out, and after the pattern is lifted out they are returned into their place in the mould. The edge of the plate is generally beveled at about an angle of 30°, and made $\frac{1}{2}''$ or $\frac{5}{8}''$ smaller than the pattern, all around.

A better way still, I think, is to have the rim loose from the arms or center, which is simply held in place by dowel pins. In this way the anchors are not needed, but the whole center of the pattern is lifted with the cope, then, when practicable, is turned over and drawn out. By the pattern maker giving the ribs and hub plenty of taper and hollow corners it will greatly assist the moulder in these delicate operations. In most cases of small bevel gear, to use a plate center and a few loose ribs on the back to stay the rim and hub is the cheapest and best arrangement. Then both the ribs and hubs are loose, and are drawn up with the cope. The style of arms which I have shown for bevel gears is used also for spur gear, very generally, because the pattern can be struck down in the mould, or drawn to make any width of face, while the arms shown with spur gear cannot be so treated, and also are costlier to make. Oval arms are generally used in machine-made gears where the center is formed by a segment core box, and therefore the width of face is not affected.



Bevel Gear Construction

A year ago a board of army and navy officers was appointed by the President of the United States, in accordance with an act of Congress, for the purpose of examining and reporting which of the navy yards and arsenals owned by the Government is best adapted for the establishment of a gun foundry, where all ordnance of the most approved patterns could be made. The president of this board was Rear Admiral E. Simpson, who has recently made a report, which was submitted to Congress. In following out their investigations into the best methods pursued in the manufacture of ordnance, the commission visited the leading arsenals and private gun foundries in England, France, and Russia. In all establishments that they visited every assistance was rendered them in their investigations, the most minute details of the work being opened for their inspection. They asked permission to visit the works of Krupp, at Essen, but this privilege was denied them. Krupp was anxious to show the United States Commissioners the performance of his guns, and offered to arrange an exhibition of artillery practice, but he would permit them to see nothing of the details of manufacture.

Industrial Depression in Scotland.

The "revenue reformers," who ascribe both industrial booms and industrial depression in this country to the operation of a protective tariff, will do well to invent some new hypothesis upon which to explain the present extreme depression and distress among the iron-workers of Great Britain, the great exemplar of free trade. The Glasgow correspondent of the London *Ironmonger* writes as follows:

"In a former letter I stated that in making the necessary reductions of wages the members of the Clyde Engineers' and Shipbuilders' Association had made an exception in the cases of the operative engineers and boiler-makers. It was then the intention of the masters, if at all possible, to leave the wages in these branches untouched, because the workmen, although skilled, were very moderate in their demands as compared with the riveters and others in times of prosperity, and were, in reality, not now overpaid. On reconsideration, and not without reluctance, the employers have been obliged to intimate a reduction of the pay of boiler-makers and engineers, as well as the other classes of employes. It may be gathered from this fact that the shipbuilding and marine engineering trades, instead of manifesting any signs of improvement, are in reality becoming more depressed. In the course of the past week large additional numbers of men have been paid off. There cannot be less than from 10,000 to 12,000 men, who a year ago were busily employed in the Glasgow shipyards and engineering works, now entirely without employment, and the roll is greatly swelled by the hands discharged at Dumbarton, Port Glasgow and Greenock. Were it not that most of the societies with which the workmen are connected are paying them several shillings a week of relief money, thousands would be without food. As it is, there is much distress, which will be aggravated as the year advances; and it would not be surprising if next winter should bring a state of things not unlike that experienced about half a dozen years ago, when, in addition to those receiving parochial relief, there were 30,000 persons in Glasgow and its suburbs entirely dependent for their daily bread upon the charity of the public."

The very low rates of wages paid even to skilled workmen in British shops make it almost impossible to live decently and save anything; so, when thrown out of employment, most of them are obliged to fall back upon their relief societies, or depend upon "the charity of the public."

LETTERS FROM PRACTICAL MEN.

General Foundry Management.

Editor American Machinist:

Perhaps the maxim, "A place for everything and everything in its place," receives nowhere less attention than in the average iron foundry. To the eye of a person who is not acquainted with foundry matters, a jobbing foundry at any time looks disorderly and confusing, but especially at night, just after a heavy heat, or the first thing in the morning, before the flasks are taken out and the sand put in shape, etc. At such times, to an outsider, it looks "confusion worse confounded."

These remarks are more applicable to a jobbing shop, where heavy work is done, than to one where only small castings are made. This disorder is, to a certain extent, unavoidable at the times referred to, but inexcusable where it exists at all times.

One moulder may often be heard remarking to another, "That is a dirty shop," or "That shop is so crowded up with flasks and rubbish that a fellow can hardly move."

An insufficiency of help often causes these "barricades" of flasks, pig iron and other material that should be outside, or placed where it will not interfere with the moulder's light or room; and, where there is not a force sufficient to keep the floors clear of such incumbrances, it certainly is to the interest of the employer to obtain more help. On the other hand, where there are plenty of good helpers, they are always not as well disciplined in the observance of order and cleanliness as they might be. This, of course, is the fault of the man who has charge of them.

No one who has not had actual experience in various localities and shops would believe what a difference there is between the management of one foreman and another. In

fact, some don't manage at all; they are too lazy, and let everything take its course, to the misery of the moulder and the loss of the firm; yet some of these very men expect a man to do a good day's work under the adverse conditions that surround him, and in some cases even succeed in getting it for a while. But a good moulder will not stay long in a shop where he is expected to work against such heavy odds all the time. A good workman likes a chance to use his tools, rather than to be doing unskilled work more than half his time, such as getting castings out, digging out holes, hunting and bringing in flasks, wheeling in new sand, carrying pig iron to weight down his moulds, throwing it off again when cast, and so on. Such work unfits a man to do a fair day's work at moulding, as will be apparent to any one who gives the matter thought. One might as reasonably expect a mason to mix his own mortar, carry it and the bricks to the place on the building required, and still do a good day's work at bricklaying; for it is apparent to every reasoning mind that the laws which operate to the lessening of both quantity and quality of work in one trade, by hindrances, disorder, general lack of unskilled help, etc., must work with equal disadvantage to a moulder.

There being, however, two sides to every question, it is only fair to allow that moulders themselves, sometimes, cause much of the disorder and confusion referred to by neglecting to utilize facilities provided for the preservation of order, such as shelves for putting gaggers upon, others for keeping patterns, gate-sticks, dry brushes, bellows, etc., where they can be seen when required, and not damaged by the feet of every passer-by, or burned by the splashing of molten iron when casting. Such facilities do not exist in many shops; where they do not, they ought to be provided. Where they do exist, it is certainly the duty of the foreman to see that they are properly made use of.

In foundries elements of danger attend disorder to a greater extent than in most factories—danger to both the workman and his work. Not unfrequently round gate-sticks on the floor have tripped up a man carrying molten iron, causing serious burns, and often spoiling valuable moulds nearly completed, by "casting them before they are ready," as the moulder expresses it. Large holes in the floor, left open, are more or less dangerous all the time, but especially so at night when casting, as the glare of the hot iron contracts the pupils of the eyes to their smallest capacity when the service of those organs is needed most, and as a consequence men often fall into such holes, receiving injuries which could easily have been prevented by placing boards across them.

One very good plan to assist the workman, when casting at night, to find his way about the floor, is to cover the ladle with a wrought-iron disk, or piece of flat wrought iron, with a handle riveted on to lift it by. The handle can be left projecting over the side of the ladle nearest the single end, and thus be easily removed by one of the men at the single end when casting. Any one who has tried this simple plan will attest to the increased safety and comfort it affords on dark nights.

Accidents often occur from the bad shape of bull ladles, many of which are made of cast-iron, with rounded bottoms. When these ladles are full of iron and placed upon the floor at hazard, they are very apt to turn over—in fact, frequently do so—causing in every case danger and confusion on the floor, and in many cases serious burns. Bull ladles, or "shanks," as they are frequently called, made of substantial wrought iron, with flat bottoms, are much safer, lighter and more durable than cast-iron ones, and the deeper they can conveniently be made, as compared with their diameter, the better. They also retain the heat better than wide, shallow ladles do, which is quite an argument in their favor generally, and especially where the moulds to be cast are a long way from the cupola, for in the cast-iron ladle described the iron cools rapidly, often causing loss of work by "cold shut," and, if the work be light and the heat duller than usual, many pieces will not run at all.

An experience of more than twenty years in the business convinces me that in some shops much money is lost through the neglect to provide the moulder with good working facilities, and in others, where moderately good advantages exist, a lack on the part of the foreman or manager to enforce their utilization must entail a proportionate loss, while the number of painful and serious accidents that occur from a lack of intelligent and vigilant management form a sufficient plea, both from a humane and utilitarian or a strictly financial standpoint, for the exercise of the best care and most well-directed intelligence on the part of him who has charge of such business. The foregoing remarks, though applicable generally to jobbing foundries, apply more particularly to shops where both light and heavy work is done.

JAMES MALLETT.

Engine Cross-Head with Adjustable Gibs—Hand-Feed Drilling.

Editor American Machinist:

In a late number of the AMERICAN MACHINIST, announcement is made of a patent on an engine cross-head with adjustable gibs.

In 1878, the Vulcan Iron Works, of Toledo, Ohio, began the making of engine cross-heads with adjustable gibs. The cross-head was tapered in the line of the guides, and the gibs fitted to the taper, and an adjusting screw was provided to take up lost motion. It is a good device, and has been in use on the engines of the above-named works for the last six years.

I wish some one had a patent that would prohibit the used of *automatic feed* on drill presses in jobbing shops. It is provoking to see boys and men put on slowest feed, and take five minutes' time to run a ¾ drill through half-inch thickness of soft cast iron. It may be urged that this is the fault of the operative. Tell this to the operative, and he will ask you if the feed was not put on there to feed with, and that he always used the slowest feed to prevent the drill breaking when it went through.

A few days ago, an ambitious young man was very much troubled because he could not do as much drilling as some older hand had done. He was using a first-class quick-return automatic feed press, with fastest feed on, drilling inch holes. I suggested that he try hand-feed, which he did, and thereby doubled his product.

OLD JOUR.

Opening Connecting Valve Between Two Boilers.

Editor American Machinist:

In your issue of June 7th I find a practical question, asked by D. H. Baldwin and J. S. Corbin, as to the disastrous effect, if any, caused by opening a globe valve between steam domes under the conditions named.

From my experience in the merchant marine service, where several boilers are generally used, I would not hesitate to open valve as described, if it was necessary to do so, care being taken to open a very little at first, and slowly all the way.

W. E. CURTISS.

Elmira, New York.

The Indicator Diagram.

BY F. F. HEMENWAY.

DIAGRAM FROM A FREIGHT LOCOMOTIVE.

The diagrams represented in Fig. 24 are from one of the cylinders of a locomotive engine on the Central Pacific Railroad, fitted with the Stevens' valve and valve gear. The dimensions of cylinders are 17″×30″; size of steam ports 12″×1″; exhaust ports 12″×2⅜″; steam lead for all grades of expansion $\frac{1}{8}$″; area of exhaust nozzle (single) 10.3 square inches. When these diagrams were taken the engine was in regular service, hauling a train of 26 loaded stock cars, the weight of train being 486 tons. The revolutions were 120 per minute, corresponding to a piston speed of 600 feet per minute, and a train speed of 20 miles per hour, presumably about the limit in speed for such a train.

The cut-off, as noted on the quadrant, was at 6″=$\frac{1}{5}$ stroke, indicated at *c* on the diagrams. It was undoubtedly a little later than this on the crank end, as will at once be seen by the character of the line at *c*. The initial pressure realized is higher than is common in the cylinders of locomotive engines, being only 5 lbs. less than boiler pressure. This is brought about from the double admission, the 12 inch port being at the beginning of the stroke equivalent to a single port 24 inches in length. There is considerable falling off in pressure previous to cut-off, much of which would probably

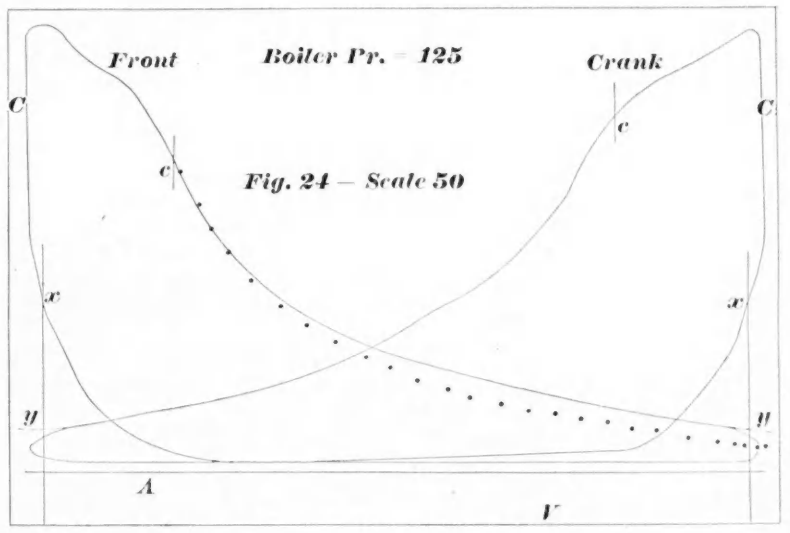


Fig. 24 — Scale 50

be avoided if the ports were longer. In respect, however, to getting high mean effective pressure from a short cut-off the diagrams show very well indeed, if the comparison is made with diagrams from the link motion.

The clearance space is given at 146 cubic inches; the piston displacement is 226.98×30 =6809 cubic inches, and the clearance is $\frac{146}{6809}$=.0214 of the displacement. The expansion line is not so good as might be expected, which detracts from the results, economically considered, that would otherwise be shown by the diagrams. The compression line is also what would be expected from twice the clearance, and is not easily accounted for. But it should not be forgotten that the cylinders of a locomotive are exposed to external cold in a much greater degree than those of stationary engines under ordinary conditions, which will influence in some degree the character of both the expansion and compression curves.

The average mean effective pressure of the two diagrams is 42 lbs.; the horse-power (both cylinders) 346. The steam at *y* occupies space just equal to the piston displacement—6809 cubic inches—and the pressure measured at *y* on the dotted prolongation of the expansion line is 26 lbs., at which pressure the weight per cubic foot is .0625 lbs. The displacement of both pistons per hour is (6809×2×2)×(120×60)=196099200 cubic inches=113483 cubic feet. The steam, in pounds, per hour, accounted for by the indicator at *y* is then 113483×.0625=7092 lbs. From this must be subtracted that saved by exhaust closure. For this purpose take the point *x* in the compression curve. The pressure at this point is 60 lbs., the weight per cubic foot .1442 lb., and the volume twice that of the clearance space, or 146×2=292 cubic inches. The steam saved per hour by exhaust closure is then

$$\left(\frac{292\times2\times2}{1728}\right)\times(120\times60)=4867$$

cubic feet—4867×.1442=701 lbs. 7092—701 =6391 lbs. of steam accounted for per hour, which is 6391÷346=18.4+lbs. per horse-power.

It has been noted that the departure of the real from the actual expansion curve indicates considerable loss. This can be seen, in part, by comparing the steam present at cut-off with that at exhaust, or at *y* in the diagram. Taking for this purpose the front end diagram, the space occupied by the steam at cut-off is (226.98×6)+146=1507.88 cubic inches—.872 cubic foot. The pressure at cut-off is 97.5 lbs.; weight per cubic foot .2260 lb., so the weight of steam in the cylinder at cut-off is .872×.2260=.1970 lb. The weight at *y* is $\frac{6809}{1728}\times.0625$=.2462 lb.—25 per cent. more than at cut-off. If we suppose nothing but dry steam to have entered the cylinder the indicator shows that 25 per cent. of it was condensed before cut-off, and it is safe to assume that as much more is present at exhaust opening, which the indicator has given no account of. This must be the assumption, or the rise in pressure of the expansion line must be charged to valve leakage.

The foregoing should not, of course, be considered in any special sense as applicable to these diagrams, the loss referred to being well understood as common, in a degree greater or less, to all steam engines.

In the course of a report recently made to Congress, the Gun Foundry Board, while speaking of steel ordnance as made in Europe, says: "Until within a very few years the steel for gun metal has been confined in England to that produced from crucibles, and it is only since the general application of the Siemens-Martin process that open-hearth steel has come into competition with it. The uniform results that are now attainable with this process show that the period for the exclusive use of crucible steel for cannon has passed. Some of the steel manufacturers have advanced very far in the use of the open-hearth, and all are making arrangements for embarking in this system of manufacture. This process is much cheaper than that by the crucible, and its success being established, that reason alone would be sufficient to cause the change in the system. But there are other reasons now operating in England which make the change of manufacture necessary in order that her steel works shall retain their position in commerce and be enabled to answer the calls made on them by the Government.

There are now about fifty-five stone-cutters employed in the Joliet (Ill.) penitentiary at wages reaching seventy-one cents a day, while citizen stone-cutters receive $4 and $4 50 per day. Those who defend such prison contracts are enemies to free honest industry. How can a free skilled mechanic, with a family to support, compete in dull times with the labor of convicts, who are worked at seventy-one cents a day? But this price is higher than the rates of most prison contracts. Nine hundred convicts are employed in Sing Sing prison making stoves at fifty-six cents a day for each able-bodied worker. The contractor, who has an outside foundry, where he employs citizen moulders, has lately ordered their wages cut down, and asks them to sign an ironclad agreement that they will not join a trade union. He evidently regards the workmen he employs as little more than slaves. How long will the people permit these prison-contract rings to use the power of the State to reduce to subjection free, honest mechanics?

A few persons, calling themselves representatives of the carpet weavers of Philadelphia, have passed resolutions condemning the practice of industrial protection. But for the fostering influence of protection, there would be no carpet weavers in Philadelphia, as the trade made no progress till it received that support.

H. C. Francis, of the Kensington Iron Works, who has recently returned from an extended trip through Europe, where he enjoyed peculiar privileges for observing machine shop practice, says that in England the practice in heavy milling is superior to ours, but that in light milling we are considerably ahead.

Estimates for Steam Users.

A PAPER READ BY CHAS. E. EMERY, PH.D., BEFORE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

§ 1. A portion of the plant of the New York Steam Company has been in operation for two years, but as many features are still in course of development, it would as yet cause some annoyance and embarrassment to publish the details of the engineering work. Bearing in mind, however, the duties of each member to contribute at least an occasional paper to the society, I present herewith in an appendix the substance of the rules on which most of the estimates of the company have been based, and propose to explain the manner in which they were developed and make some suggestions as to their adaptation for general use.

§ 2. The first problem was to fix a unit by which steam could be sold. A horse-power, when considered simply as expressing the rate in which mechanical work is performed, is definite, but a horse-power of steam varies with the size and kind of engine used, and must be referred to an arbitrary standard. We adopted the customary standard of thirty pounds of feed water per horse-power per hour. Most of the engines supplied were small or without expansion gear, and required more than thirty pounds, and had to be charged for more; and for miscellaneous uses, such as heating buildings, boiling soap, melting wax, ripening fruit, etc., the cost had to be finally estimated from the feed water or water of condensation, and as every use could be referred to this unit, its adoption seemed necessary. Confusion would, however, arise in the minds of consumers between pounds of water evaporated into steam and pounds of steam pressure, so a new unit seemed necessary which would be as distinctive as a ton of coal or a thousand feet of gas.

§ 3. We commenced selling steam in February, 1883, at a specified price *per thousand Kals*, explaining that a *Kal* was equivalent to a pound of water evaporated into steam, and thereby solved the problem for our special purposes. The term is employed regularly by our representatives and our consumers. Many of the latter understand it, and all use it. For instance, a dignified bank president has had a clause inserted in his contract that the price per thousand kals to his corporation shall be as low as to our most favored consumer, and, without knowing anything technical about it, explains to his associates that *that is the way steam is sold*.

§ 4. The writer believes that such a term would be useful generally as well as specially, and would feel personally complimented if engineers and representatives of the different journals would use it in an alternative way to test its convenience and necessity. The word "kal" is, of course, based on caloric, a relic of the material theory of heat, and, like "calorimeter," from the same source, is designed to represent a measure of heat—each pound of water at a certain pressure taking up a definite quantity of heat. The short word *kal*, spelled as it is with a *k*, need not be confounded with the French *calorie*, or thermal unit.

§ 5. The pressure at which the pound of water is evaporated is not of great practical importance. The number of thermal units derived from the fuel with a temperature of feed of 100° is less than three per cent. greater when evaporation occurs at seventy pounds pressure than when it takes place at atmospheric pressure, and the variation for the customary range of working pressures is, of course, much less. For ordinary purposes, therefore, the term can be used, the same as the expression "pounds of water evaporated" is now, without reference to pressure. It is, however, desirable that the value of a kal be definitely fixed in standard thermal units.

§ 6. The "unit of evaporation" is now accepted to be the evaporation of a pound of water from and at 212°, and the thermal value is, therefore, 965.7 thermal units. It would be desirable for simplicity to make the kal equal to this, but there are serious practical objections to it. The kal is to take the place of the unit in the expression "pounds of feed water" or of "water of condensation" required per hour for engines and other purposes. Its value should, therefore, be founded on the evaporation from a fair average steam pressure and from a fair average temperature of feed. The author, in the report of the judges on the tests of the boilers at the Centennial Exhibition, presented what was termed the "Commercial Evaporation," viz.: the evaporation at pressure of seventy pounds from temperature of 100°, and the "Commercial Horse Power," based on thirty pounds of feed water per horse power per hour, evaporated on same basis. The seventy pounds pressure had been accepted before, but the evaporation was generally assumed from 212°. In the report it was stated that 100° temperature of feed could always be obtained, even with condensing engines, and that frequently the temperature was little greater with non-condensing engines. Most engineers will agree that as a standard for horse-power thirty pounds of feed water evaporated under actual working conditions is small enough, though entirely fair when good and bad engines are considered together, and that, although good heaters may raise the temperature of feed to 180° and occasionally higher, a temperature of 100° is nearer the average than 212°. The heat obtained in excess of 100° may properly be credited to surplus boiler power, which is so often deficient.

§ 7. The proposed standard of horse-power has already been accepted by several experts in suits as to power of boilers, and is known as the Centennial Standard of Horse Power, or the Centennial Horse Power. It is therefore proposed to make the value of a kal the same as the unit of Commercial Evaporation above named.

§ 8. We have then based on the thermal or heat unit—

1. The accepted "unit of evaporation" (E) with a thermal value of 965.7 thermal units.*

2. The kal (K), equal to one pound of water evaporated into saturated steam at seventy pounds pressure from temperature of 100°, with a thermal value of 1110.2 thermal units.

$$[K = .86984\ E;\ E = 1.1496\ K.]$$

3. The Centennial Horse Power (*C. H. P.*), which equals simply thirty kals per hour.

§ 9. By a pleasing coincidence, the volume of one kal is almost precisely five cubic feet, hence the weight of a cubic foot, or the "heaviness" (D), as it is expressed in Coxe-Wiesbach, is .2 pound.

§ 10. We are now prepared to examine the rules for making estimates previously referred to, and the reader will first please examine §§ 32 and 33 in the Appendix.

§ 11. It will be observed that the charges for heating are based on the ordinary steam-fitter's method, using the *capacity* of the buildings, instead of the area and thickness of walls, area of windows and roof, extent of ventilation, etc. These rules are founded upon investigations of the cost of heating a large number of business buildings in the city of New York under actual practical conditions. The variation in cost between different buildings of similar construction and exposure was found to be very great, due doubtless to differences in apparatus and management, and made useless any elaborate system based on calculating the number of thermal units passing through window glass or walls of different kinds and thicknesses.

* The number of heat units here given would be varied slightly by consulting different formulæ and tables. The figures given are those adopted by the U. S. Navy as published by Isherwood, and given in Nystrom's Mechanics and Porter on the Indicator.

These rules, when applied, of course, with good judgment, simply give prices for which business buildings of the kind described should be heated satisfactorily during the ordinary business hours of an average heating season—say ten hours per day for 200 days in the year. With care the work can be done more cheaply, but when the steam is used from a district system where pressure is maintained continuously, janitors and porters will use the same prodigally by leaving it on day and night, or by neglecting to shut off radiators so as to properly graduate the heat to the demand, thereby increasing the cost in some cases very materially.

§ 12. The reader will now please examine casually § 40 to § 48, Appendix, and afterward more carefully in connection with the following:

§ 13. The formulated rules for the power and the cost of the power (§ 43) are very simple, and readily applied. The first step is to obtain the continued product of the square of the diameter of cylinder in inches (d^2), the stroke of piston in inches (s), and the revolutions per minute (r). This product is a factor in the equations for the power as well as for the cost of the power. In equation (4) § 43 the power P equals the product referred to, multiplied by a constant co-efficient (.000004), and by the mean pressure (m). The co-efficient is, of course, made up of the product of $\frac{\pi}{4}$ (required with d^2 to give the area), and $\frac{2}{12}$ (required with s to show double stroke in inches reduced to feet) divided by 33,000. A more exact result of the operation would give a co-efficient of .000003966, but the value .000004 used is correct within less than one per cent., and was therefore satisfactory for the purposes in view.

§ 14. Eq. (5) is derived directly from (4).

§ 15. The cost of the power is estimated in all cases from the number of cubic feet capacity developed by the piston. It is at first assumed that the cylinder is at every stroke filled completely with steam of the initial pressure, but a multiplier is provided in the formula, which is varied according to the known conditions to approximately give the corrected result. There are required to be known by this process: 1, the volume developed per unit of time; 2, the weight per cubic foot of the steam; and 3, the factor of correction above referred to. In formula (6) § 43, the expression for the number of kals per minute (k) is made up of the product ($d^2\ s\ r$) referred to in connection with the power, and the co-efficient is simply the joint product of factors to reduce the expression independent of factors a and n to cubic feet per minute, and of another factor, viz., .0023, belonging with the factors a and n yet to be explained.

§ 16. Complete formulæ representing the weight of a cubic foot of steam [viz., the heaviness (D)] at all practicable pressures are usually quite complex. The writer finds that the results shown by Rankine's elaborate formulæ are represented equally well between the limits of 1 and 1,000 pounds pressure by the simple expression,

$$(1) \qquad D = .0030343\ p_1^{.94},$$

hence

$$(2)\ log.\ D. = \bar{3}\ .4820505 + .94\ log.\ p_1,$$

p_1 being the absolute pressure obtained by adding 14.7 pounds to the pressure by gauge. It was found, however, that the following still simpler equation of a straight line was sufficiently accurate for practical purposes within customary limits, say from atmospheric to 80 pounds gauge pressure, viz.,

$$(3) \qquad D = .0023\ (p + 17),$$

p being the gauge pressure. The $p + 17$ should not be confounded with $p + 14.7$ or $p + 15$ representing the absolute pressure. It is to be remembered simply that for absolute pressures varying as $p + 15$ nearly, the density and "heaviness" vary within ordinary limits as $p + 17$ nearly.

§ 17. By the method adopted, the initial pressure is assumed to be the mean pressure plus the average back pressure, so it will be seen that the values of n in § 42 of Appendix simply provide for varying the initial pressure with the back pressure by adding the value of the latter above the atmosphere to $m + 17$. In formula (6) in Appendix, the value of n corresponds to $p + 17$ in formula (3) above, and the co-efficient of latter being already introduced in co-efficient of (6), the heaviness (D) due to the initial pressure of steam is introduced, and the formula, independent of a, simply multiplies the number of cubic feet of steam per minute by the weight of a cubic foot at initial pressure.

§ 18. The factor a simply corrects the expression according to table, § 41, to approximate actual conditions, more particularly as to expansion, internal cylinder condensation, and probable leaks. If the engine be operated without expansion, and neither of the losses mentioned be considered, the value of a should be unity. In some elevator engines there is no expansion whatever, but the losses are considered as 20 to 30 per cent., making a equal 1.2 to 1.3, as shown in table. The expansion obtained with a plain slide valve reduces the cost materially, so the value of a is fixed at .85 for large engines and 1.1 for very small ones in which various losses overbalance the gain due to expansion. For cut-off engines the value of a varies from .6 for large engines to .9 for the small ones.

§ 19. It is so natural to suppose that there should be some consideration of the expansion curve in an equation proposing to deal with the economy of an expansion engine, that this method of using a simple co-efficient of correction will at first sight seem strange to all. If many here present were jointly developing an equation, there is every probability that a discussion would soon be in progress whether the hyperbolic or the adiabatic curve of expansion should be considered. The formulæ under discussion stand on higher grounds. Though approximate only, they include the more important conditions. Independent of large engines, and exceptionally good small ones, all that the wisest of us know about cost of steam power is that the average costs of average engines of certain kinds, under average conditions are certain figures, the values of which would not be changed greatly by individual opinions. Here, then, is a basis superior to all minor details as a means of arriving at the result. For the purposes of this case the values of a are varied to produce the corresponding values of k_p or kals per horse-power per hour in last column of table § 41, and if there be differences of opinion as to the proper values of k_p, the values of a can be varied to suit. To a mathematician it is plain that if we know the result to be obtained, a factor in an equation which is constant for particular conditions can be changed to suit other conditions. Unfortunately, it is often thought that the value of many formulæ lies in the constants. The natural inquiry comes, Why not use the results direct without any formula?

§ 20. In this case there are good reasons. With non-condensing engines, the most important variations in the cost of the power are caused by simple variations in the ratio of the back pressure to the effective, or, better, the total pressure. If this fact be considered, other variations in result from engines of the same general size and design, using steam of the same quality, will be almost entirely due to differences of mechanical condition. The relative effective pressure is provided for perfectly in the formula. The basis in all cases is the cost of the power absolutely without expansion—the initial pressure being assumed equal to the mean and back pressures. Expansion simply furnishes an indicator diagram of the *same* area, with one portion made higher in order that the other can be lower and reduce the cost, though not proportionally to the lowering of the pressure.

§ 21. The multipliers a in table § 41 of Appendix are calculated for the values of k_p in same table with the mean pressure m equal to about 30 pounds for the cut-off engines, and about 40 pounds for the others. The comparative results given by formula for a fair-sized engine which would be customarily rated at 30 to 40 horse-power, considered, first, as a slide valve engine, and, second, as a cut-off engine, for different mean pressures and constant back pressure above atmosphere of two pounds ($n = m + 19$), are shown in the following table:

MEAN PRESSURE (m) AND INDICATED HORSE-POWER (P).	5	20	40	80
Slide valve engine $a = .85$:				
Kals per horse-power per hour k_p ...	128.52	52.21	39.49	33.13
Kals per hour k_1	642.6	1044.2	1579.6	2650.4
Cut-off engines $a = .60$:				
Kals per horse-power per hour k_p ...	90.72	36.5	27.87	23.4
Kals per hour k_1	453.6	730.0	1114.8	1872.0

§ 22. The table shows very forcibly the influence of the back pressure; the cost of the power rising rapidly as mean pressure is decreased and reducing materially for high mean pressure, without any consideration of expansion whatever, except that the percentage of saving between the slide valve and expansion engines is assumed to be the same for the same power and development. This may not be true precisely, but is approximately true within ordinary limits. An exception was thought neccessary for engines running very light, for the rules provide—see § 49, Appendix—that minimum charges shall be based on $a = 1$, etc., which practically charges the cut-off engines with slide valve minimum rates, as is evidently nearly correct. For case given in § 21 above, the minimum charge by this modification would be 661.5 kals per hour, the indicated power being that due to the friction pressure, and the useful power, zero.

§ 23. It will be seen that a slide-valve engine, run with high mean pressure, can readily give better results than a cut-off engine with low mean pressure. Very simple reasons may explain wide differences in results obtained under different conditions.

§ 24. It is well-known that large cut-off engines of approved make in some cases operate more economically than shown in table, but the formulæ were intended to give results approximately correct, though on the safe side for small engines of average construction, and have in practice been found to answer the purpose very satisfactorily.

§ 25. Formula (7), § 43, derived from (6), gives the number of kals required per thousand revolutions of an engine. When the work is substantially uniform, the simplest way to account with a consumer is to apply a counter and charge by the thousand revolutions, basing the price on a mean pressure sufficient to perform the maximum work.

§ 26. Formula (8), § 43, is a modification of the others, to give directly, if desired, the kals per horse-power per hour. Note that the factors $d^2\ s\ r$ disappear from this formula, as they should, as they occur in both divisor and dividend in making the combinations.

§ 27. The remainder of the rules will, I think, be understood without detailed explanation, except, perhaps, equation (12), § 55, Appendix, showing the number of kals per trip of ordinary steam elevator engines. This formula gives what are called high costs, but it has proved insufficient for this class of engines when constructed with piston valves, many of which seem to offer very slight resistance to the passage of the steam from the boiler to the exhaust pipe. For slide-valve elevator engines the formula gives approximately accurate results. These engines are generally made absolutely without expansion, with small ports, and are run at high speeds. The small ports generally require cylinders altogether too large for the work, so that the mean pressures are low and the costs correspondingly high.

§ 28. An examination of the notation § 54 will show that the revolutions r_2 apply to a trip in *one* direction. The return trip is provided for in the quantity $m_{11} + 46$, in equation (12), § 55, which is made up of $m_{11} + 21$, corresponding to n_2, § 42, plus 4 + 21; four pounds in excess of back pressure being considered necessary to lower the elevator. If $m_{11} = 10$ pounds, as it frequently does, the cost in ascending is proportioned to $10 + 21 = 31$, and in descending to $4 + 21 = 25$, which do not differ at all proportionally to the useful power exerted. In fact, it is difficult to tell whether such an elevator is ascending or descending by watching the exhaust pipe.

§ 29. The following calculations apply to a specimen elevator, with double 8 × 10 cylinders, in regular use in New York:

W = say 1,200 pounds. T = 200
L = 75 feet. b = 2.5
r_2 = 100 revs.

Then

(11) $m_{11} = 13.125$
(12) $k_t = 19.1$
(13) $k_2 = 3820$

A trip is usually made in $\frac{7}{2}$ minutes, so in § 41, $r = 171.4$.

(4) $P = 11.5$ ascending.
3.5 descending.
7.5 average.

k_t being 19.1, $k = \frac{1}{7}\ k_t = 32.7$, $k_1 = 98.1$, $k_p = 130.6$.

§ 30. APPENDIX TO PAPER OF CHAS. E. EMERY, ENTITLED "ESTIMATES FOR STEAM USERS."

ENGINEER'S DEPARTMENT—THE NEW YORK STEAM COMPANY.

Rules to be observed in making estimates by the division of steam supply.

§ 31. Offers, estimates and contracts may be made for a stated price, but must in every case contain a reservation of the right to apply meters, as given in regulations. Regular meter rates to be 60 cents per M. kal. In contracts for considerable amounts, 50 cents per M. kal will answer when the consumption can be accurately ascertained.

HEATING.

§ 32. Estimates for heating will be based on the capacity of the rooms heated, and the following rates, varied by judgment, according to exposure, temperature and use of the rooms and the amount of ventilation:

§ 33. Minimum rate, $2.50 per thousand cubic feet per season for deep buildings with minimum exposure, or fairly well-lighted rooms used as workshops for manual labor, when the heating surface is limited, or so divided that it can be regulated to use small portions at once. Office buildings, well lighted, generally require $3 per M. cubic feet; buildings with large windows about $4 per M. cubic feet, and those with unusual exposure and good ventilation $4.50 to $5 per M. cubic feet.

Cost of heating estimated from heating surface:

§ 34.

Steam Pressure.			
20 lbs.	.6	Kals per sq. foot of heating surface per hour.	
40 lbs.	.7		
80 lbs.	.8		

§ 35. For steam tables, etc., augment actual surface of table and uncovered pipes reasonably to allow for food, cover, moisture carried off, etc.

§ 36. Charge for uncovered pipes in basements full time, day and night.

§ 37. Ordinary heating season, 200 days of ten hours. Allow about five days per season steam on one-fifth surface all night.

§ 38. With ordinary heating apparatus it is supposed the radiators will, on the average, be shut off at least half the time allowed for heating.

§ 39. For dry rooms special calculations are necessary, founded on the conditions of the particular case. The steam required will vary principally with the quantity of air circulated and the weight of moisture carried off. A steam meter, or some arrangement to measure the water of condensation to be applied in every case of this kind.

POWER.

§ 40. All power will be estimated for in units to suit the customer, but the estimates are to be based on calculations for the costs in kals, which are to be spread on the reports of surveys for the information of the engineer.

§ 41. The following notation and formulæ will be used as required.

Let k = Kals per minute.
k_1 = " " hour = 60 K.
k_2 = " " day.
k_m = " " 1,000 revolutions.
k_p = " " indicated horse-power per hour.
P = indicated horse-power.
d = diameter of cylinder in inches.
s = stroke of piston in inches.
r = revolutions or double strokes per minute.
p = pressure above atmosphere.
m = mean pressure in cylinder.
a = a multiplier varied under conditions given in table to allow for expansion and provide for cylinder condensation, clearance, and other losses.

§ 41.	*HP.*	a.	k_p.
Cut-off engines..	40 and up.	.6	30
	20	.7	35
	10	.8	40
	5	.9	45
Slide valve engines.....	30 and up.	.85	40
	15	1.00	45
	5	1.10	50
Elevator engines, new, good order		1.1	55
Elevator engines, small and old		1.2	60
	DIAM. STEAM CYLINDER.		
Compound pumps...	20" and up	.75	35
	16"	.85	40
	5"	1.00	45
Ordinary steam pumps.....	20"	1.0	50
	15"	1.1	55
	12"	1.2	60
	8"	1.3	65
	5"	1.4	70

n = multiplier varied from $m + 17$ up, under conditions given in table, to allow for probable back pressure.

§ 42. $n_2 = m + 21$ for quick elevator engines.
$n_3 = m + 20$ for small fast engines and small pumps.
$n_4 = m + 19$ for engines with free exhaust.
$n_5 = m + 17$ or $p + 17$ = minimum; useful only in calculations where back pressure is not considered.

(To distinguish $p + 17$ from $p + 14.7$, see close § 16.)

§ 43. (4) $P = .000004\ (d^2\ s\ r)\ m.$

(5) $m = 250000\ \frac{P}{d^2\ s\ r}.$

(6) $k = .0000021\ (d^2\ s\ r)\ a\ n.$

(7) $k_m = .0021\ (d^2\ s)\ a\ n.$

(8) $k_p = 31.5\ \frac{a\ n}{m}.$

APPLICATION OF THE FORMULA.

1st Case.—*When the mean pressure (m) is known.*

§ 44. Ascertain the power from (4) and its cost from (6), (7), or (8), as required.

§ 45. (*A*). The mean pressure can be accurately ascertained with the indicator, and this is the only method when engine is fitted with a fixed cut-off.

§ 46. (*B*). When the engine operates intermittently, the estimate may be made on an assumed mean pressure of say 40 pounds, and a price given per thousand revolutions based on results from (7) with $m = 40$, the contract stipulating that the power is not to exceed that given by (4) with $m = 40$.

§ 47. (*C*). The mean pressure may be derived from the pressure in steam chest. For accuracy, the ratio of the mean pressure to pressure in chest should be ascertained by the indicator for each particular engine, and this ratio used as a factor of a. For practical purposes, with slow engines—like pumps—using steam full stroke, or nearly so, with cylinder ports of ordinary size, m is to be taken equal to pressure in chest, using value of a, as per table, and n_5. For quick engines, deduct one-tenth from tabulated value of a, and use n_5 with m = pressure in steam chest, which will apply to slide valve engines at all times; to automatic cut-off engines, when regulated by throttle with governor belt thrown off, but not to engines with fixed cut-offs. The last rule is on the basis that the loss of pressure entering cylinder is balanced by using a lower value of a.

2d Case.—*When the power is given which is to be developed in an engine of a given size.*

§ 48. (*A*). Find m from (5) and cost from (6), (7), or (8), as required.

§ 49. *Note.* All contracts for horse-power actually developed will name the minimum charge for operating the engine. This will be stated on surveys and ascertained from (6), (7), or (8), as required, by making $a = 1$ and $m = 0$ in value of n used in the other calculations, and adding also 1 to 3 pounds for friction pressure.

HYDRAULIC ELEVATORS.

§ 50. If D = diameter of hydraulic cylinder in inches,
d = as before, diameter of steam cylinder in inches,
d_1 = diameter of pump cylinder in inches,
S = stroke of hydraulic piston in feet,
s_1 = stroke of pump in inches,
T = number of trips of elevator per day,
l = height in feet between water tanks,
r_D = number of double strokes of pump per day,
f = multiplier = 1.25 for large pumps, say steam piston 20" diameter, increased to 2.0 as steam piston decreases to 10" diameter.

§ 51. Then: (9) $m = .434\ \frac{d_1^2}{d^2}\ f\ l$

(10) $r_D = \frac{6\ D^2\ S\ T}{d_1^2\ s_1}$,

from which k_2 may be obtained from (6) by substituting k_2 for k and r_D for r.

§ 52. *Note.* In this calculation only one pump is considered. If the pump be duplex the actual strokes will be half those calculated by formula, but the steam used will be the same. [N. B.—In calculating power or cost for duplex pumps, the reading of a counter on one pump should be doubled.]

§ 53. For compound pumps refer m only to the large cylinder. The size of the small one does not enter the calculation.

STEAM ELEVATORS.

§ 54. Let W = unbalanced weight of car and load.
L = lift.
m_{11} = mean pressure in each cylinder of double engines.
r_2 = number of revolutions of engines required to run car from bottom to top of shaft, or *vice versa*, (to be counted by Solicitor)
k_t = kals per trip.
T = number of trips per day:
b = 1.75 for geared elevators.
b = 2.50 for screw elevators.

§ 55. Then for double engines—

(11) $m_{11} = \frac{3\ 82\ b\ W\ L}{d^2\ s\ r_2}$

Multiply by 2 for single engine.

(12) $k_t = .00000504\ (d^2\ s\ r_2)\ (m_{11} + 46)$

Divide by 2 for single engine.

(13) $k_2 = T\ k_t.$

STEAM PUMPS.

§ 56. For ordinary steam pumps raising water in a building, m, may be found from (9), and the pump considered as run a certain number of strokes per minute for a certain number of hours per day, as reported by engineer and confirmed by the practice in other buildings. If a certain sized circular tank is filled a certain number of times per day, (10) applies by making D = diameter of tank, S its depth, and T the number of times it is filled per day, and then proceeding as described in connection with (10).

HEATING WATER.

§ 57. For water heated from 60° to boiling point.

Kals = No. gallons × $1\frac{1}{3}$ = No. pounds × $\frac{1}{6}$ nearly.

STEAM JETS.

§ 58. Charge for open steam jets discharging against atmospheric pressure.

d_0 = diameter of jet.

15 lbs. st'm press. kals. pr. hr., $k_1 = 1216\ d_0^2$
45 " " " " $k_1 = 1804\ d_0^2$
60 " " " " $k_1 = 1978\ d_0^2$

Calculate for pressure of 60 pounds except when jet works off a heating system at lower pressure, or when the full opening of valve would drive employes from the room.

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The Industrial Situation.

It is a fact widely known that business in most machine shops, both East and West, is just now quite dull. There are occasional exceptions, but these do not represent the general state of trade. It is also a fact that the dullness has not caused alarm among machine shop proprietors, probably because they are, as a rule, better prepared for a dull season than at any previous time when it has been precipitated upon them. Not being gifted with prescience, we shall not undertake to point out how long the dullness will last. Some months ago a prominent machinery firm, in answering our request to note the state of trade in their establishment, gave expression to a sound view, which will bear repetition at this time. It was this:

"As to the prospects for business during the coming year, we do not pretend to know much; but, being very decidedly of the opinion that this country is not yet finished, we have no doubt that somebody will have something to do."

New enterprises are naturally delayed by declining prices. When there is reasonable assurance that prices of shop, factory and railroad equipments are at or near their lowest ebb, there will be numerous purchasers, for there is abundant capital awaiting safe investment.

One of the most favorable elements in the situation is the settlement of iron-workers' wages for a year to come without a reduction. This not only prevents a lock-out of tens of thousand of workmen, involving immense loss to the producing interests of the country, but has a strong tendency to strengthen prices of iron, and everything into which iron enters as the chief component. A reduction of ten per cent. in wages would be followed by a reduction in prices of finished product. No more iron would be sold, but the weakening of prices would have a disturbing effect, which it would take many months to overcome. But the downward tendency of wages and selling prices of iron and machinery has been checked. Stocks of iron and machinery are light, and there is good reason to believe that if the bottom has not been reached it is not far off.

Annual Report of the Iron and Steel Association.

We have received the annual report of Mr. James M. Swank, Secretary of the American Iron and Steel Association, for 1883, and find therein an assortment of valuable information for those interested in the industrial welfare of this country. The report consists principally of carefully-compiled statistics showing the condition of the iron trade in America, to which are added particulars of the iron trade in all foreign countries. Although figures predominate in the report, Mr. Swank has sandwiched between the statistics numerous readable items regarding the condition of the trade on which he is such good authority. He does not regard the depressed state of the iron trade with apprehension, although it is admitted that it has grown steadily worse in the last year; but the stagnation and hopelessness which successively characterized the trade after the panic of 1873 have not overtaken it during the existing depression. There have been many financial failures, but they are merely the result of enterprises undertaken with insufficient capital and enterprises which were badly managed, the searching ordeal of dull trade serving to show their weakness. The decline in prices having been gradual, the shock of a sudden drop was avoided, and the prices of finished products and raw material receded uniformly. A noteworthy exception to the general adjustment of prices is in the action of the anthracite coal producers, who have combined to maintain the old high prices unbroken. If this policy is persisted in, the production of anthracite pig must decline, and statistics show that this decline has already begun.

The secretary of the Iron and Steel Association believes that the continual agitation among politicians against the protective tariff has a disturbing and depressing effect upon the iron industries of this country. What any serious reduction of duty would inflict upon our iron-workers is indicated by the condition of lines of metal-work that are now insufficiently protected. Rods adapted for making wire and iron and steel cotton ties are subject to a low rate of duty, the consequence being that large quantities of the rods are imported, and no cotton ties are now made in this country. During the last six months of 1883 the importation of iron and steel cotton ties amounted to 13,453 tons, which would have kept several of our rolling mills at work that are now silent had our interests been properly protected. There is no reason why the South should not make its own cotton ties, but no beginning can be made till more effectual protection is provided.

Although the decrease in the production of iron and steel has been very serious, a good, sound business remains, and manufacture is restricted to the requirements of a healthy demand. The decreased demand for railroad rails has been to some extent balanced by the introduction of Bessemer steel into other branches of industry. In some cases, Bessemer steel is taking the place of cast and wrought iron, which transfers but little benefit to the iron trade; but, on the other hand, mild steel is finding application for purposes where wood and stone formerly were used. The miscellaneous forms where steel is now adapted embrace bridge work, elevated railroads and tramways, structural purposes generally, car and locomotive work, shipbuilding, the making of agricultural implements, plates and sheets, wire rods and nails. Nearly all the barb wire used is made from Bessemer steel rods, too many of which are imported owing to the low duty classification. The production of barb wire in this country has developed with surprising rapidity in ten years. In 1873 the total quantity of barbed wire made is reported not to have exceeded 60 tons; last year it amounted to 100,000 tons. The total production of Bessemer steel during 1883 was 1,654,627 tons, being only 41,823 tons less than that turned out in 1882. This work was done by fifteen establishments, representing 38 converters. The first blow of basic steel in this country took place at the Pennsylvania Steel Company's works on May 7, 1883, and the prospects for success in this line of production are reported to be satisfactory.

The conclusion arrived at from a careful study of Mr. Swank's report is that, although the iron and steel trade is in a condition that offers little attraction to draw new capital into the business, the trade is working on a sound basis. When other lines of business become active, and increased demand arises for the product of our furnaces, the iron-masters will be in good position to reap profits that are now absent.

Prison Contract Legislation.

Notwithstanding the immense popular majority cast at the last fall election in the State of New York in favor of abolishing the prison contract system, the Legislature adjourned without doing anything to institute any other plan to employ the convicts in the prisons. The bill that was passed forbidding the letting of any more contracts before the next Legislature meets was a trick and a subterfuge to stave off the question without settling it. A majority of the Legislature was in favor of the prison contractor's ring, and deliberately disregarded the recorded will of the people. The prison contractors, and their supporters in the Legislature, now ask, with brazen effrontery, "What are you going to do about it?" There is a strong probability that a number of ring statesmen will have to be permanently retired to private life before the people's will becomes law, and the prison contract system becomes a thing of the past.

The Legislature of Ohio, at its last session, passed a bill not only to stop further contracts with private parties for the labor of convicts, but also to provide for the employment of all convicts by the State directly in useful employments. In other States the matter has made considerable progress, notably in New Jersey, and the days of prison contract competition with free labor in this country are certainly drawing to a close.

Cotton Seed Oil Progress.

There are one hundred and eight cotton seed oil mills in the South. The mill proprietors have formed an association (outsiders call it a combination). Cotton seed oil is in active demand, and every gallon produced is readily sold. Besides using it to manufacture bogus butter, it is labeled and sold as pure olive oil. To more effectually carry out the deception, large quantities are sent to Italy, bottled and labeled "Huyle d'olive," then shipped back again to this country. The importer is thereby enabled to testify that the oil comes direct from the land of the olive, and to dispel any doubts that may arise in the minds of inexperienced customers. One drawback to this enterprise is the recent action of the Italian Government in raising the import duty on cotton seed oil. The oil men want relief, and talk of sending Congressman Morrison as a missionary to the Italian national legislature to get up a "horizontal reduction" bill.

The extension of the cotton seed oil mills in the South keeps rather close to the available supply of seed. Seed is worth ten or twelve dollars a ton at the mill, and, on the average, from a ton of seed may be expressed about thirty-three gallons of oil. Refuse, after the oil is expressed, sells for fertilizing purposes. As a whole, the industry is profitable, and it has enabled the planters to dispose of a product for cash that previously was mostly given away. Important improvements have been made in machinery for cotton seed oil mills which we shall refer to in the future.

We continue our account of the proceedings of the Mechanical Engineers at Pittsburgh, by publishing in full, on pages six and seven, a paper on Estimates for Steam Users, read by Charles E. Emery, of this city. Our press proof of this paper has been revised by the author, not to the extent of making any alterations in the text, but to the correcting of many typographical errors that appeared in the proofs distributed at Pittsburgh.

Mr. Emery has established a new unit—the kal—for the measurement of steam in the business with which he is prominently connected, because of the need of something more expressive than horse-power, when applied to the steam required to supply steam engines, using all the way from twenty-five to one hundred pounds of water per horse-power per hour, and particularly when applied to the measurement of steam used for heating buildings, for drying, cooking, etc. Stating the horse-power required to heat a building, for instance, is, to say the least, awkward, quite as much so as to say a gas light or an electric light is a certain horse-power. More especially it is both awkward and confusing, when it is considered that there is no agreement as to what a horse-power is when it comes to the boiler, or to the steam furnished by it. The new word has the merit of practical exactness, and is one about the signification of which no dispute need arise.

To those not especially interested in the unit of measurement there are many points of interest in this paper, relating to the economy of different classes of steam motors, to the steam required for different purposes, and to novel methods employed in making the necessary computations. The author's standing as an engineer, and the fact that the conclusions detailed have been reached by him after careful study and consideration, and for the purpose of establishing an accurate commercial basis upon which to sell steam, commend them to more than ordinary attention. The formulas used are quite simple, requiring nothing more than the substitution of definite quantities and simple arithmetical calculations. The paper as a whole is one of especial interest to men who value such things for the practical use they may be able to make of them. Its pre-

paration cost a good deal of study, and we commend it to the attention of our readers with faith in its value.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials, nor location will be published.

(240) L. S., Chicopee, Mass., asks: Please give me a rule for finding the size of a tap drill. *A.*—See answer to question 4 in AMERICAN MACHINIST of February 14, 1880.

(241) H. J. B., Cincinnati, O., asks: Please give me a rule for proportioning drop hangers for shafting; that is, the amount of metal or weight for the different sizes of shaft? *A.*—This is a matter of machine design that cannot be stated in the form of a rule.

(242) S. D., Columbus, Ohio, asks: Can you give me a rule by which to find the radius of a segment [circular arc] by figures? *A.*—The following rule is from Trautwine: "Square one-half the chord; also square the whole rise; add these squares together; divide the sum by twice the rise."

(243) O. B. F., Huron, Dak., asks: Can hard coal screenings be economically burned with soft coal for making steam to run a pump at our water works; and, if so, can they be used on the grates as used for soft coal? *A.*—If the boilers are large for their work, it would be possible to burn a small amount of hard coal screenings with the soft coal, but not to any great extent. Screenings can be burned by using a special, finely-perforated grate and a blower, and there are some special boiler settings adapted to burn them.

(244) J. N. B., Columbus, O., asks: Will you give the the strain in pounds on a ⅞ bolt, nine threads per inch, with an 18" wrench, with a pull of 30 lbs? *A.*—In a complete revolution, the point at which the power is applied to the wrench (18" from center) will travel 113", while the motion of the nut in line with the axis of the bolt will be 1-9", hence the leverage will be 113+1-9=1017 to one. Assuming the friction to be 50 per cent, the strain will be 1017×15=15255 lbs. If the friction is greater or less the strain will be varied proportionately.

(245) A. P. R., Harrison, Me., writes: We have a boiler 36" diameter, 12 feet long, with thirty tubes 3" diameter. It is set in masonry in the usual manner. We burn wood, and the grate is 18" from the shell. I should like to ask if the boiler setting is right? *A.*—You do not give any particulars of setting, except the distance of grate from shell. We should say this distance should not be less than 30". The bridge wall may be 6" from shell. Behind the bridge wall, the distance from shell may be 14", tapering up to 9" at the back end of boiler.

(246) Engineer, Petaluma, Cal., says: Please state in your columns how to find if the pins in locomotive driving-wheels are at right angles to each other, and if not at right angles, which is the most simple mode of correction where there is no press for taking wheels off axle? *A.*—The ordinary way to test wheels to find if the pins are properly quartered, is to put the crank-pin on one side so that its center is in a line level with the center of the axle. By means of a plumb-line, it can then be ascertained if the center of the crank-pin on the other side is in a vertical line passing through the axle. Some shops have squares, made specially for making this test. Adjustment of a badly-quartered engine is sometimes made by an eccentric crank-pin. The wheels being a little out, in quartering, does not injure the working of a locomotive, so long as both sides are the same.

(247) J. N. F., Crescent City, Cal., writes: Our engine, 28"x36", is fitted with the Meyer cut-off. It runs 85 revolutions per minute, and does the work with 80 lbs. steam, cutting off at 18". The work is driving large triple circular pony gang, edger, shingle mill, large box factory, with many other small saws, planers, conveyer, etc. When the triple circular saws are out of the cut the engine runs noiseless, but when the saws are in a large log (some of them are eight feet diameter) the engine pounds considerably. The valve has but little exhaust lap, so the compression is low. To make up for this, I gave the valve ⅛", and then ¼" lead. The engine still pounds, but not so badly as before. Everything about the engine is in line, and the journals are all close. Why should the engine pound when the saws are cutting, and not pound when doing the other work alone? What do you think about the lead? *A.*—Pounding is a very common trouble with engines fitted with the Meyer cut-off, for the reason that the main valve has, usually, but little outside or inside lap, and hence does not close the exhaust until nearly the end of the stroke. If the compression is not higher than the pressure on the other side of the piston, at the end of expansion, there is always a tendency towards pounding. When the saws are working the terminal pressure is above compression, hence the engine pounds. When the saws are off, the work being less compression is higher than the terminal pressure, and the engine runs still. Make the lead whatever will assist in bringing about smooth running. There is no objection to ¼" lead, if the engine runs better with it.

(248) C. L. C., Lowell, Mass., asks: 1. What is the heating surface of a boiler of the following dimensions, viz.: Length 15 feet, diameter 5 feet, number of tubes 77, diameter of tubes 3¼"? *A.*—The heating surface in the shell is

$$15x\left(\frac{5x3.1416}{2}\right)=117.8 \text{ feet.}$$

The heating surface (internal) of a 3¼" tube is 0.788 feet per foot of length, hence the total heating surface of tubes is 77x15x0.788=910.14 feet. The heating surface in the heads may be estimated at 10 feet, making the total heating surface 117.8+910.14+10=1037.94 feet. 2. Is the heating surface properly proportioned to the grate surface? *A.*—You do not state what the grate surface is. 3. This boiler is evaporating 10¾ lbs. of water to 1 lb. of coal. Is this a good result for this kind of boiler? *A.*—The result is very good indeed.

(249) W. D., Perth, Ont., asks: 1. What is a safe working pressure for the boiler of a steam fire-engine, the shell being made of 3-16" steel, the boiler being well made? Such a boiler should be capable of carrying 100 lbs. pressure. We believe that a higher pressure than this is sometimes carried. We cannot say what your boiler ought to be allowed to carry. A very common working pressure for steam fire-engines is 75 to 80 lbs. 2. Would it not be a good plan to have an injector with which to feed the boiler in case the feed pump should fail? *A.*—We can see no objection to such an arrangement. 3. Which do you think best for a fire-engine, a piston or a rotary pump? *A.*—Either works satisfactorily when well made. The piston pump is the most common. 4. Are not the valves of a piston pump likely to get stuck, if the suction is lying on the bottom of the river? *A.*—There is some danger of this, and if possible to avoid it the suction should not reach the bottom, then with a proper strainer there is generally no trouble. 5. The river is shallow here. How can I keep the suction from the bottom? *A.*—Fasten a guard to the strainer, so as to keep it from the bottom. 6. What is the best piston speed for a steam fire-engine, so that the valves will have time to seat? *A.*—One hundred feet per minute is very good speed for pump pistons. Probably you will have to run faster. The limit of speed depends largely upon the construction. The only satisfactory way is to find by trial at what speed you get the best results. 7. If the piston speed is so high that the pump does not fill, is there not danger of breaking something when the piston strikes the water? *A.*—Yes.

BUSINESS SPECIALS

Transient Advertisements, 50 cts. a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

Mackenzie Cupolas and Blowers. 245 Broadway, N.Y.

Springs—List free. T. F. Welch, 11 Hawkins st. Boston.

Presses & Dies, Ferracute Mach. Co., Bridgeton, N. J.

Steel Name Stamps, &c J. B. Roney, Lynn, Mass.

Interchangeable work a specialty. Send stamp for new Lathe Catalogue. E. O. Chase, Newark, N. J.

For first-class machine patterns and estimates, address John Valentine, 15 Alling st., Newark, N. J.

INVENTIONS perfected, designed, or patented. E. P. Robbins, M. E., Cincinnati, O.

"How to Keep Boilers Clean." A book mailed free, by James E. Hotchkiss, 86 John street, N. Y.

Fine tools and special machinery. Horace Thurston, 84 Clifford street, Providence, R. I.

Herbert W. T. Jenner, Mechanical Engineer and Solicitor of Patents, 632 F st., Washington, D. C.

Lyman's Gear Chart. How to lay out gear teeth. Price 50 cents. E. Lyman, C. E., New Haven, Conn.

Foot Power Machinery, for workshop use, sent on trial if desired. W. F. & John Barnes, Rockford, Ill.

The latest Improved Tack and Match Machinery is made by White Machine Co., Waterbury, Conn.

Pattern and Brand Letters. Vanderburgh, Wells & Co., corner Fulton and Dutch streets, New York.

Consulting Engineer and Mechanical expert, C. C. Hill, 84 Market street, Chicago, Ill.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

National and box chucks, foot and power lathes, and slide rests. Lodge, Barker & Co., Cincinnati, O.

Guild & Garrison's Steam Pump Works, Brooklyn, N. Y. Steam Pumping Machinery of every description. Send for catalogue.

Improved Tack Machinery, made by The Willets Man'f'g Co., can be seen in operation at their works, 57 Clifford St., Providence, R. I.

The "Wax Process" Engravings shown in the AMERICAN MACHINIST each week are made by Struthers, Servoss & Co., 32 Frankfort Street, N. Y.

Difficult machines invented and built; coarse screws cut V rotary files for fine milling, by mail 50 cts. Tower Machine Works, E. Brookfield, Mass.

Engine Lathes, Hand Lathes, and other fine tools. Assortment large; prices low. Frasse & Co., 62 Chatham St., N. Y.

The Complete Practical Machinist, $2 50; the Pattern Maker's Assistant, $2.50; Mechanical Drawing Self-taught, $4 00; books for practical machinists. Address, Joshua Rose, Box 3,306, New York City.

EXTRACTS FROM CHORDAL'S LETTERS, 400 pages, 12mo., handsomely bound in cloth. New and enlarged edition, with over 50 illustrations. Price $2. Published by John Wiley & Sons, 15 Astor place, New York.

MANUFACTURES.

Battle Creek, Mich., is talking of starting a $50,000 wagon works in the Upton building.

Pittsburgh parties are figuring on erecting cast-iron pipe works, at West Middlesex, Pa.

G. W. Davis & Co., Nashua, N. H., are putting in the foundation for a large addition to their machine shop.

Simon Straus, 750 Fifth street, New York, will erect a large six-story factory, at 179-183 Lewis street, to cost $35,000.

A building three hundred feet long and costing $25,000 is to be erected at Batavia, N. Y., for the Post Sewing Machine Company.

The Manning Novelty Company, of Youngstown, O., will erect an extensive plant during the summer, to be ready for occupancy in the fall.

Jacob & George Lorillard, 3 Mercer street, New York, will erect a two-story brick factory, 100x60 feet, at 726 to 732 East Fourteenth street.

P. Barnes, Worcester, Mass., writes us, under date of June 3d: "We made the first heat of Bessemer steel in the new plant of the Washburn Iron Company this afternoon."

The New York, Lake Erie, and Western Railroad Company have been using the Barthel solidified oil on their locomotives with satisfactory results. They use this mixture with the ordinary oil cup, which is slightly changed to adapt it for the pasty condition of this lubricant.

Prentice Brothers, Worcester, Mass., have just got out a new and finely-illustrated catalogue of machine tools built by them. They build upright drills of original design, from 26" to 50" swing; also lathes of several sizes. Recently they have brought out two new designs of upright drills.

George B. Grant, Alden street, Boston, will remove his gear wheel business June 1st to 66 Beverly street, where he will have double the room and greatly-improved facilities. He is putting in machinery for cutting gears to six feet diameter, as well as apparatus for cutting racks and internal gears.

The Empey Car-Brake Company has been incorporated at Detroit, Mich. The capital stock is fixed at $200,000, in eight thousand shares. The business of the company will be to manufacture car brakes, under the Aldridge & Huggins patent, with all improvements made and to be made thereon. The principal office will be in Detroit.

The foundations for the addition to Hoyt & Bros. Manufacturing Company's machine shops, at Aurora, Ill., are laid. The structure, which is to be 60 by 70, will be ready to receive the machinery within thirty days. This will give the company about one-third more floor-room. They are bringing out some new designs of machinery which will shortly be placed on the market.—*Industrial World*

Dwight Slate, Hartford, Conn., writes us: My business is very slack in the special line, but I have sold as many sensitive drills as I expected, also marking machines and cutter grinders, and had a good sale of my cutting-off tools. I have made two shipments to England since February, and have another to make next month. My sensitive drills seem to "take" in that country. I make a rose-reamer grinder especially for English trade, and one concern (who grind their twist drills on the Professor Sweet plan), with almost Yankee ingenuity, use it for a twist-drill grinder.

The Lidgerwood Manufacturing Company, 96 Liberty street, New York, have made an announcement cautioning the trade against being misled by the notice of Joseph S. Mundy. They say ample guarantee will be given against claims of infringement by Mundy or other parties. Under the court's decision, Mundy is only entitled to claim an immaterial attachment, viz., the spring between the spur-wheel and drum, while Knowlson—under whose patent the Lidgerwood company manufacture—is held to be the prior inventor of the friction mechanism.

While in Indianapolis, recently, we had the pleasure of visiting the Dean Brothers' Steam Pump Works, and were shown through the new shops, which our readers will remember we illustrated about two years ago. The works are laid out with special view to neatness and convenience. Light and ventilation are well provided for. Even in the foundry cleanliness is carefully observed. Quite a variety of steam pumps are made in these shops, and the finished product will compare favorably with that of any other establishment either East or West.

The H. C. Frick Coke Company, of Pittsburgh, Pa., manufacturers of Connellsville coke, have issued a pamphlet in regard to the use of "Frick Coke" in foundry cupolas. As our readers already know, coke has supplemented coal as a fuel for melting in many of the best Eastern foundries within the last two years. This pamphlet gives directions for using the coke in cupolas as well as records of some experience in its use, also a list of prominent establishments now using the "Frick coke." Agents for this coke are: E. Cheney, Boston; H. W. Harris, Philadelphia (313 Walnut street), and Geo. S. Lyon, Chicago.

There are being manufactured at the Midvale Steel Works (Nicetown), Philadelphia, eight 6-inch and two 5-inch breech loading rifles for the new naval cruiser, Chicago, in course of construction at Chester. They are called "built-up" or "hooped" guns, inasmuch as they consist of a tube-jacket and superimposed cylinders or hoop shrunk on. The 6-inch guns will be sixteen feet and one inch in length and will weigh 10,000 pounds each. A charge will be used which, it is said, will throw a projectile weighing 100 pounds.

We recently received a call from Mr. John Lang, of John Lang & Sons, machine tool builders, of Johnstone, Scotland. Mr. Lang, who is spending a few months in the United States, reports the machine tool business good in Scotland. His firm builds la hes with cut gears, instead of cast gears, which are generally used by British tool builders. The advantages of cut gears are being recognized in that country, and Mr. Lang believes that all tool builders will eventually adopt them. He has secured the agency for Gould & Eberhardt's Universal Automatic Gear Cutter, which was illustrated in the AMERICAN MACHINIST of March 31, 1883. One of these machines has been used in their works with the most gratifying success.

The Billings & Edmunds Manufacturing Company, with $20,000 capital, has been incorporated in Connecticut. The incorporators are: C. E. Billings, (president of the Billings & Spencer Company), George D. Edmunds, L. H. Holt, E. K. Stocker, and F. C. Billings, all of Hartford. The works are to be located at Rocky Hill, near Hartford. The corporate articles say: "The purpose of said corporation is for the manufacture and sale of machinery, machinists' and other mechanical tools, spinning rings and hardware, composed wholly or in part of metal, and such other goods and merchandise as said corporation shall choose, and conducting such mercantile and mechanical business as may be necessary for the successful prosecution of such business."

The St. Louis *Age of Steel* says: The Great Western Railroad Supplies Company have selected a location for their works just outside the limits of the city of East St. Louis, near Heine's brewery. The ground upon which they will build is 300 feet one way by 700 the other, and was donated to them by Messrs. John B. Bowman, Henry Voss, and Caspar Schultz. Ground for the works will be broken next Monday, and the first building upon which work will be commenced will be 70x300 feet, and will contain the hammers and rolling mills. The puddling and other departments will be in separate buildings, which will be built later on. The works, when completed, will turn out wrought iron and steel forgings, steamboat, mill, and engine shafting, locomotive frames, equalizers, axles, bumpers, draw heads, draw bars, bumper and follower plates, couplings, links, pins, frogs, brakes, engine and car bearings, and "all descriptions of wrought and cast-iron work for bridges." The company was incorporated under the laws of the State of Illinois, with a capital of $500,000, and its officers are: President, John Wilson; vice-president, James Millan; treasurer, Dr. J. H. McLean.

The National Pipe-Bending Company, are selling, from twenty-five to thirty feed-water heaters a month. Among the recent sales are the following: R. F. Hawkins, 40-horse, Springfield, Mass.; Colt's Fire-Arms Company, Hartford, Conn.; Fishkill Machine Works, 40-horse, Fishkill, N. Y.; Standard Silk Company, 60-horse, Tobyhanna, Pa; Hanes & Jencks, 40-horse, Haverhill, Mass.; United Iron Works, one 80-horse, one 200-horse, Poughkeepsie, N. Y; Bates & Johnson, 80-horse, Syracuse, N. Y.; John J. Asch, 100-horse, South Norwalk, Conn.; steamer J. C. Thomas, 60-horse, New Haven, Conn.; steamer F. C. & A. E. Rowland, 60-horse, New Haven, Conn; J. B. Gardner & Son, 80-horse, Ansonia, Conn.; Twitchell, Champlin & Co., 100-horse, Portland, Me.; Emerson Wight, 150-horse, Springfield, Mass.; Peck, Stow & Wilcox Company, 150-horse (third heater), Southington, Conn.; Buerket & Co., 80-horse, Boston, Mass.; Eagle Lock Company, Terryville, Conn; Perrin Plow Works, Topeka, Kan.; Bradley & Hubbard Manufacturing Company, 300-horse, Meriden, Conn; E. M. Ivens & Sons, New Orleans, La.; Jenney Electric Light Company, Brockton, Mass.; Lee, Blackburn & Co., 150 horse, Lawrence, Mass; Boyle Ice Machine Company, 60-horse Kingston, Jamaica, W. I.

Manning Maxwell, & Moore, 111 Liberty street, New York, have taken the store 113, next door to their old place, and are going to use the additional accommodation to extend and facilitate their business arrangements. For some time back they have been getting badly crowded to provide for the necessities of their increasing trade, and this extension will enable them to handle their varied assortment of goods to greater advantage. The partition between the two stores has been cut through, so that the two stores are perfectly accessible one from the other. The homely gratings have been taken up in front of the whole building and a water-tight iron covering, lighted by glass bull's-eyes, put down. The windows have been extended down to the sidewalk and fine plate-glass fronts put in. The different floors, from the cellar upward, have been fitted up with shelving and partitions, so that all the different goods can be classified and kept apart in the best reachable order. One apartment is entirely devoted to machine tools, another to steam fittings, such as the consolidated safety valve and all its necessary attachments, injectors, indicators, and all similar goods. Cornices are secured round all the main rooms, from which pictures are hung representing places and things in which the company are interested directly or indirectly. This forms quite an interesting picture gallery, some of the exhibits being art productions of no small value.

Machinists' Supplies and Iron.

NEW YORK, June 5, 1884.

The condition of the supply trade remains unchanged.

Iron, pig, American—The settlement of the question of wages at Pittsburgh, for the ensuing year, has imparted a hopeful tone to the iron trade. Business is quiet, and no new transactions of any magnitude have transpired during the week. The production of standard brands is limited carefully to meet the demand. We quote No. 1 X Foundry, $20 to $21; No. 2 X Foundry, $18.50 to $19, at tide water; Grey Forge, $16.50 to $17.

Scotch—The market continues quiet, with values in buyers' favor. Shotts, $21.50 to $21.75, to arrive: Coltness, $21.50, to arrive, and $22 from yard; Eglinton, $19.50; Langloan, $21; Dalmellington, $19.50.

Copper—The demand for ingot continues light, and dealers show a disposition to make slight concessions on prices. Lake, 14⅛c. to 14¼c.; other brands, 13¾c. to 13⅞c.

✲WANTED✲

"Situation and Help" Advertisements, 30 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

A young man, first-class lathe hand, wants a job. Address BOX 11, AM. MACHINIST.

Experienced mechanical draughtsman desires position, as draughtsman or superintendent. Address H. A., AM. MACHINIST.

Mechanical engineer and draughtsman, with good references, wants engagement. Address BOX 3, AM. MACHINIST.

A good tool maker wanted; one accustomed to make tools for engineers and plumbers' brass work. Address James Morrison, 75 Adelaide street, west, Toronto, Canada.

Draughtsman (scientific graduate), experienced in general machine design, and with some practice as civil and hydraulic engineer, desires position; would like opportunity to advance. Address C. S. B, AM. MACHINIST.

Wanted—Live Foreman, for a machine shop in Western Canada, on first-class engine and mill work. Apply, with terms, to "Tar," care of AM. MACHINIST, New York.

A student, who has nearly completed the course required in the Hoboken Institute of Technology, in addition to a course in civil engineering, would like employment in either branch. Address C. H. Lindenberger, Defiance, O.

Situation wanted, as foreman of a boiler shop. Have had 20 years' experience as foreman, and am conversant with marine stationary and locomotive work. Address George Marshall, care AMERICAN MACHINIST.

Wanted—A good, practical iron moulder to take half-interest in a small moulding shop. For a suitable man we have a first-class opening here. For further particulars write to Jesse Astall, West Strand Iron Works, 67 Strand, Galveston, Texas.

A thoroughly-educated mechanical engineer and draughtsman, well posted in steam engineering, desires an engagement enabling him to prove his worth. Highest references from leading American and foreign shops. Has designed original machines for leading firms. Address "BOX 15," AM. MACHINIST.

Experienced mechanical engineer is open to engagement. Good draughtsman. Has had charge of works. Specialty steam engineering in all its branches; expert with indicator; competent to design, handle men, or travel. Good record; best of references. Address BOX 9, AM. MACHINIST.

Wanted—A first-class superintendent, to take charge of an architectural iron works, who understands plans, and is accurate in figuring quantities. Must be strictly temperate and have good recommendations. No others need apply. Address Wm. Bayley & Co., 340 Second avenue, Milwaukee, Wis.

For Sale—One No. 2 Brainard Universal Milling Machine, as good as new. Wells Brothers & Co., Greenfield, Mass.

Inventors, desirous of having their inventions manufactured and placed on market, should write to Barbour Brothers, Tarentum, Pa. Agents wanted, to sell a new machinists' tool, well established.

Wanted—Second-hand screw-cutting engine lathe, to swing not less than 50 inches and take about 13 feet between centers. Must be of modern build and in first-class order. Address D. J. Murray Manufacturing Company, Wausau, Wis.

Address, TAYLOR MFG. CO., Chambersburg, Pa.
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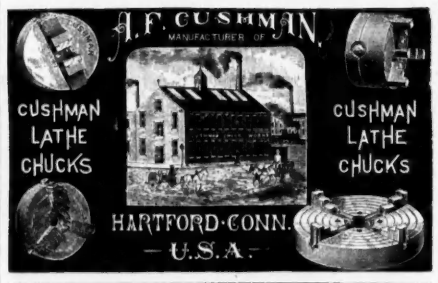

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3—9 in. Stroke Shaper. [6 ft. 9 in.
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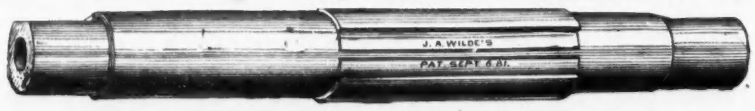

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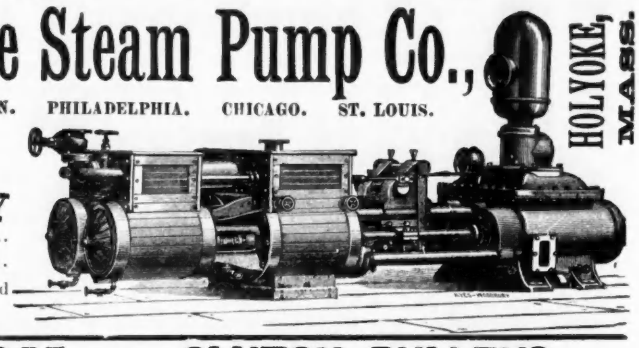

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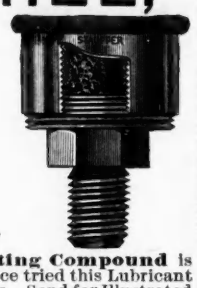
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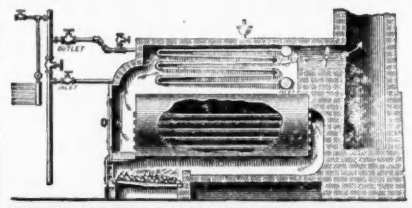

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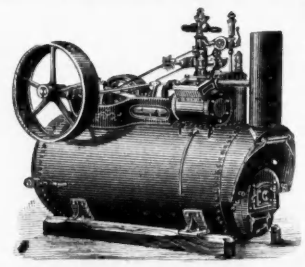
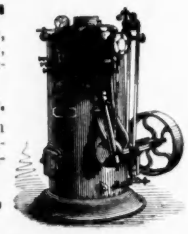
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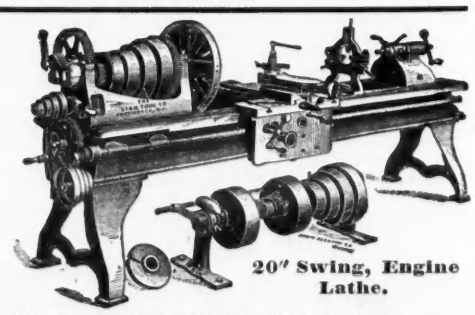
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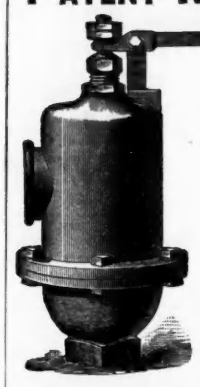

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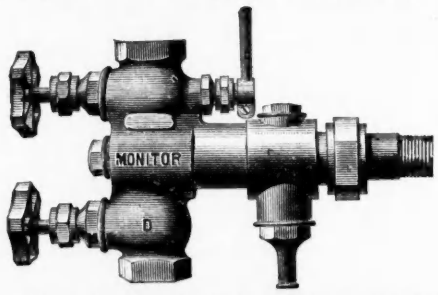

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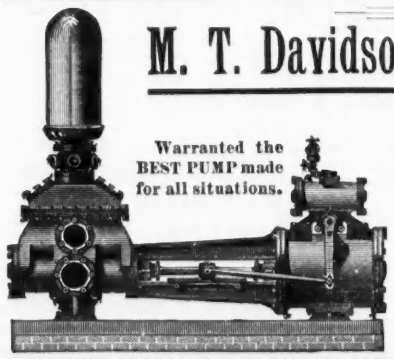

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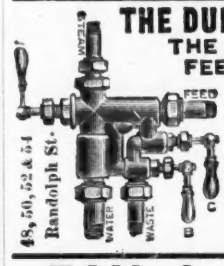

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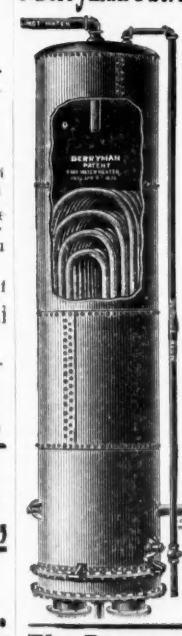

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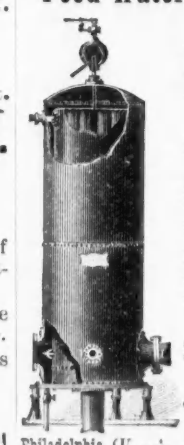

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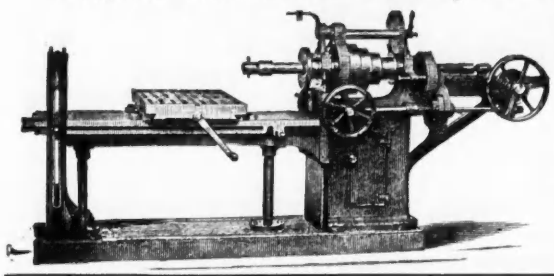

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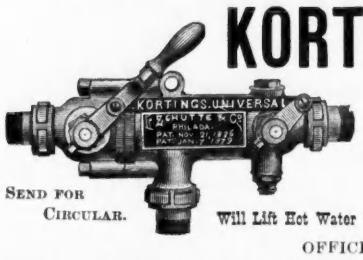

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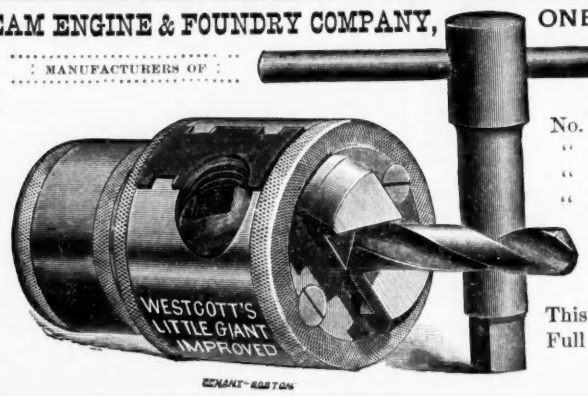

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No.	00	0	to 1/4	in.
"	0	0	" 1/2	"
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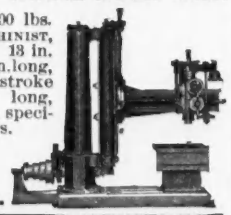

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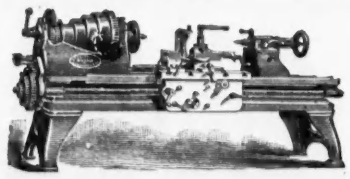

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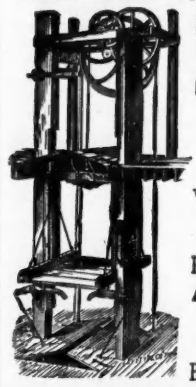

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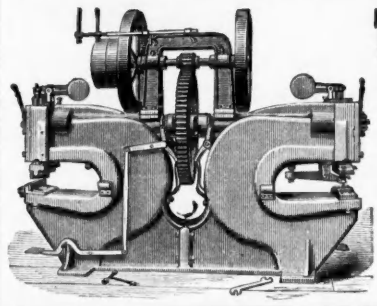

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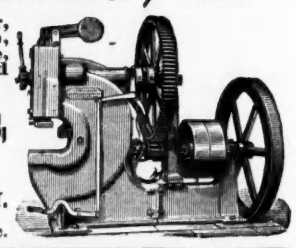

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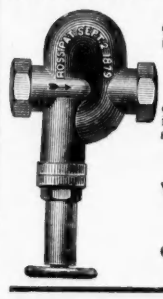

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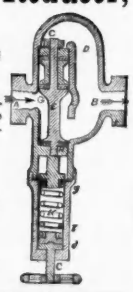

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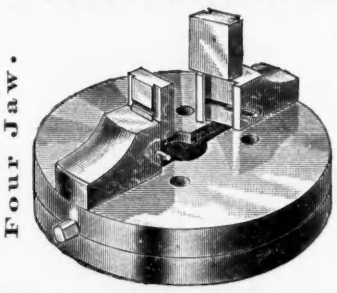

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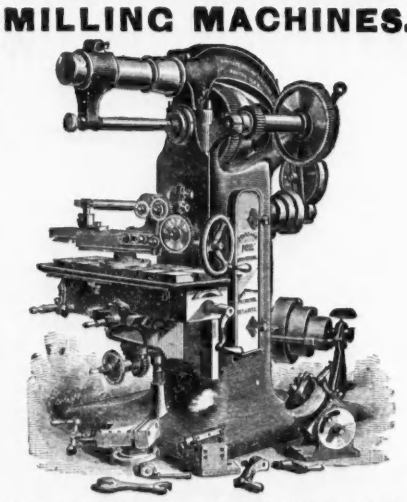

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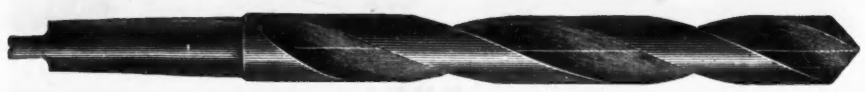

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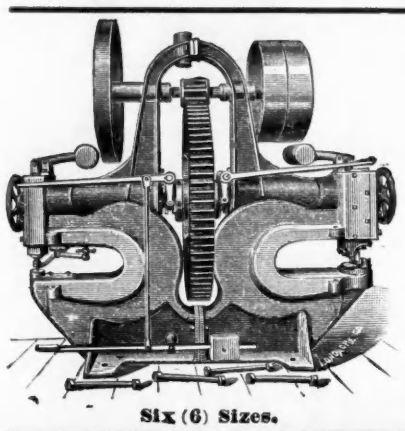

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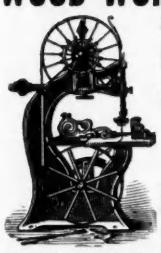

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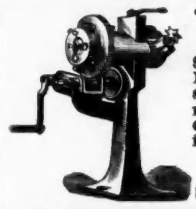

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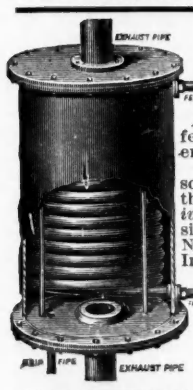

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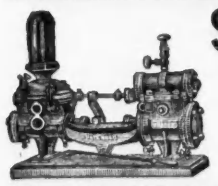

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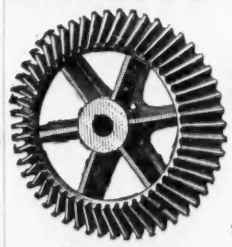

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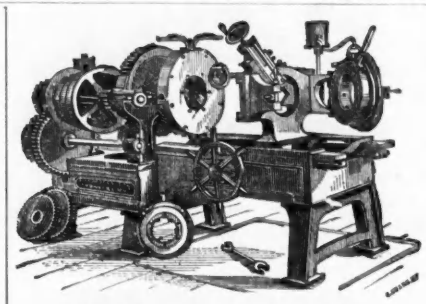

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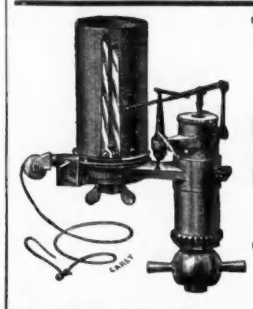

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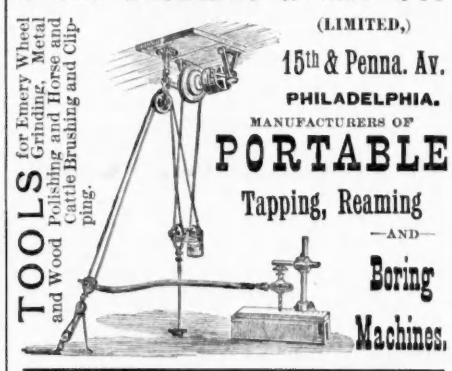

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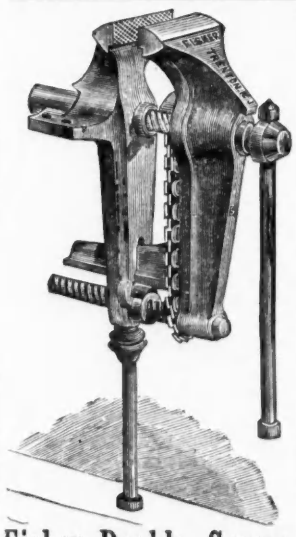

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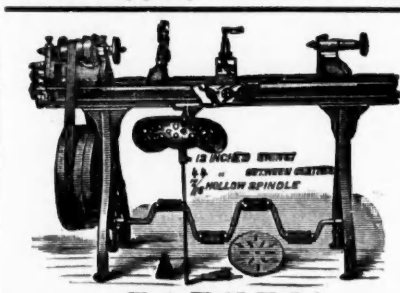

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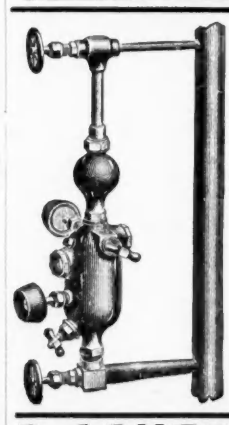

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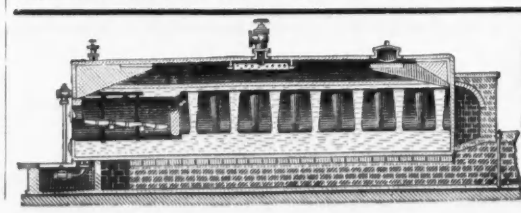

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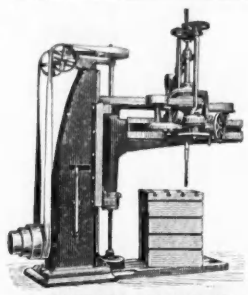

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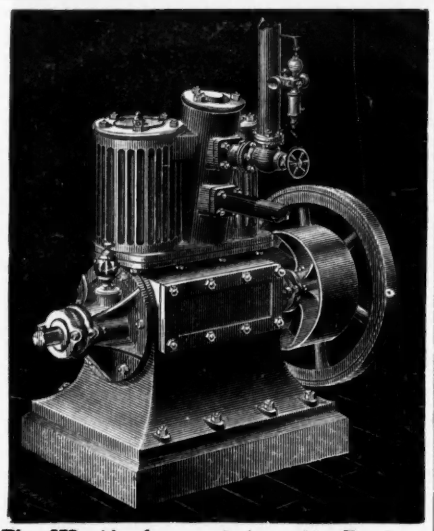

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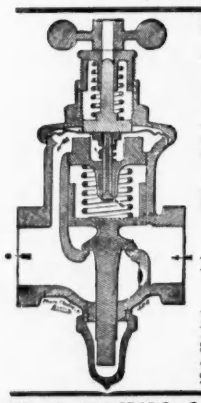

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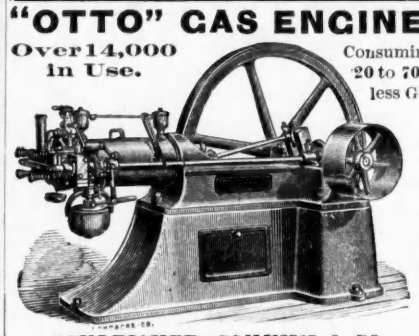

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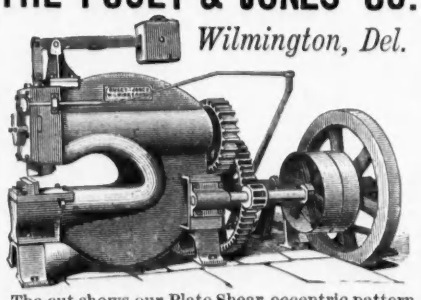

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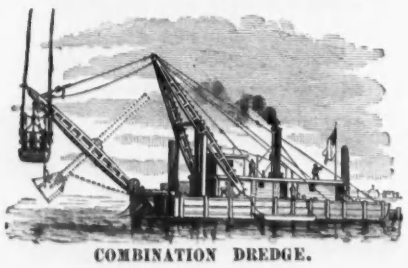

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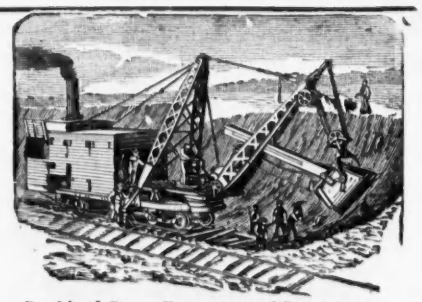

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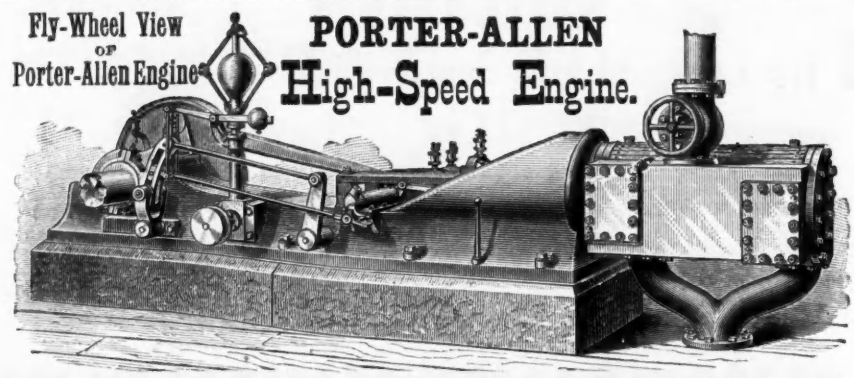

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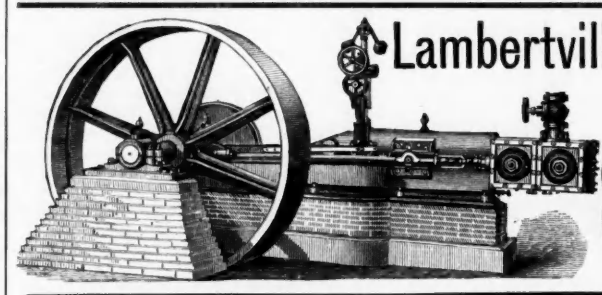

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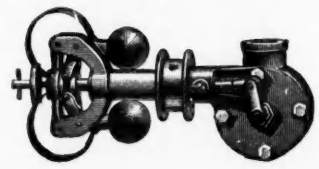

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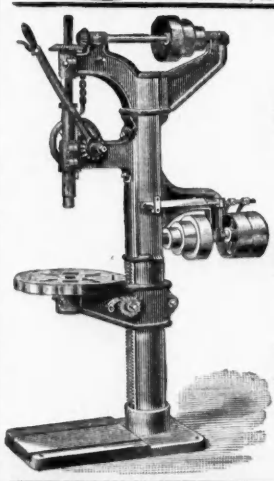

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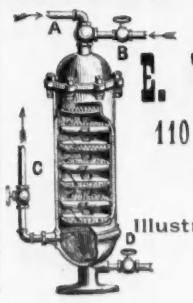

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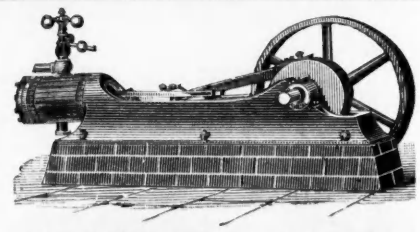

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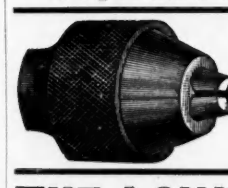

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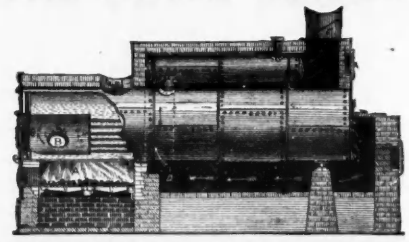

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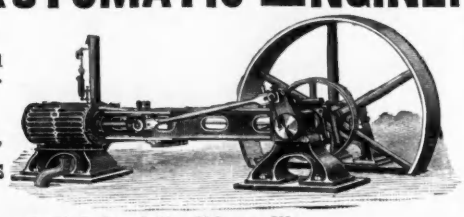

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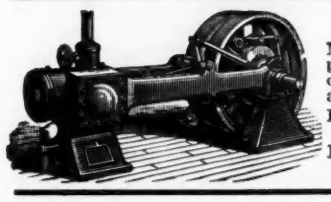

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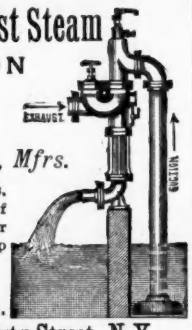

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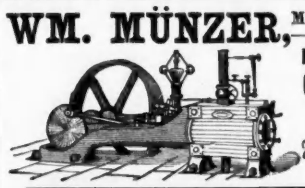

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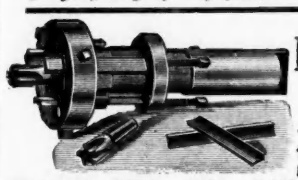

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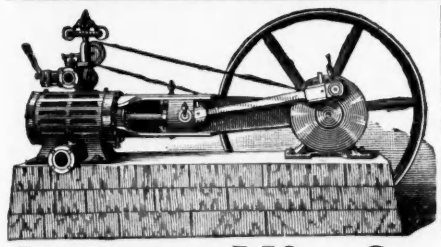

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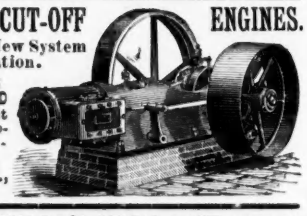

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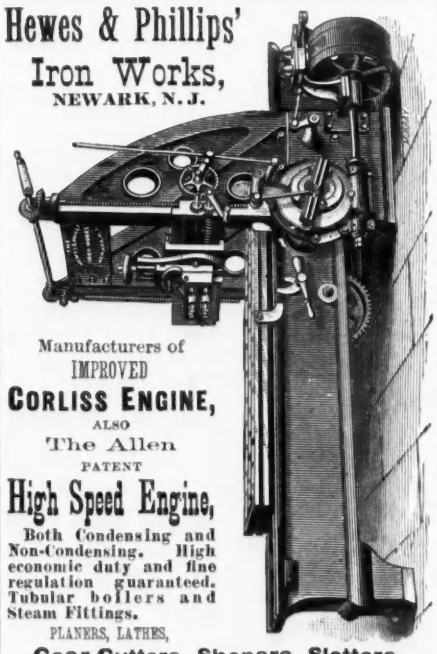

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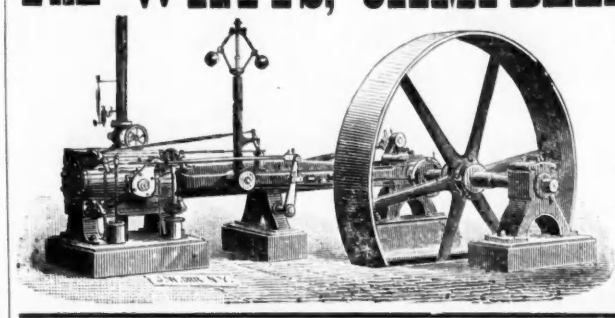

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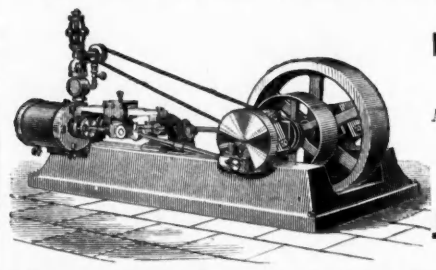

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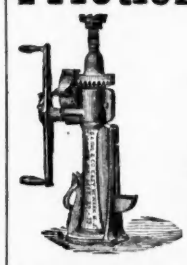

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1 " " 15 in. x 6 ft. Chelsea Machine Co.
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1 Lincoln Pattern No. 2 Millers 1 9 in. Shaper.
1 Bolt Cutter, to take sizes to 1 inch.
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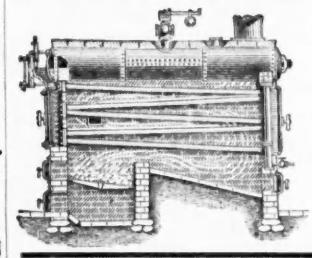

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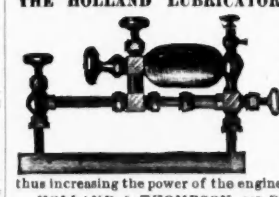

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One Iron Planer, to plane 8 ft. long, 30x30 in.

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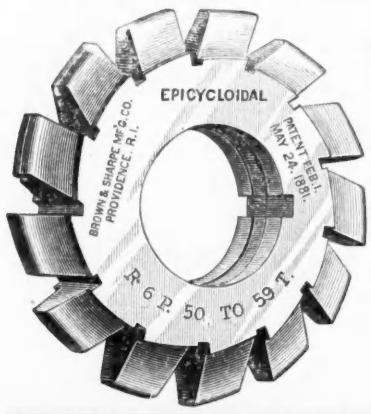
Patent Epicycloidal Cutters,

FOR THE TEETH OF GEAR WHEELS,

Which can be Sharpened by Grinding without changing their form.



We are prepared to furnish Cutters of Epicycloidal form, which are sharpened upon the face the same as the Involute Cutters. As gears of this form of teeth to run well must be cut accurately to the proper depth, that the pitch lines may coincide, we make the Cutters with a shoulder (see cut), which determines the exact depth that the gear should be cut; so that care taken in sizing the blanks obviates the necessity of any measurements in cutting the teeth. The Cutters are made for either diametral or circular pitches, and the same rules apply in finding the diameters of blanks as in our system of Involute teeth, (i. e.) 2 pitches added to the diameter at pitch line.

These Cutters will cut gears which are perfectly interchangeable. The white line on edge of the two left hand upper teeth of cut is left for the purpose of placing the Cutter central with work spindle. The Cutters are marked with letters from A to X, by which they may be ordered.

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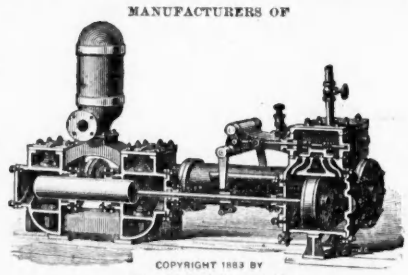

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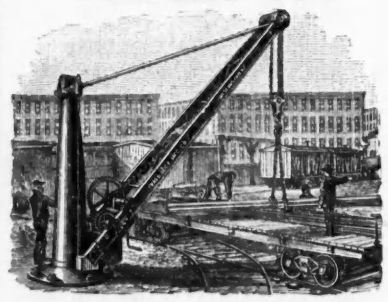

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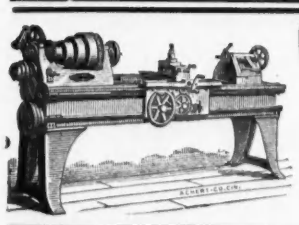

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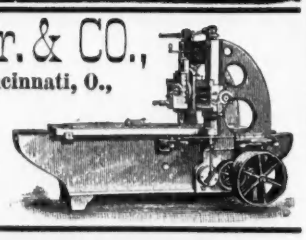

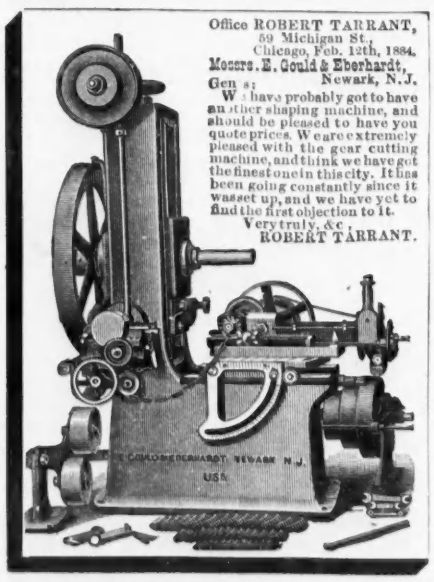

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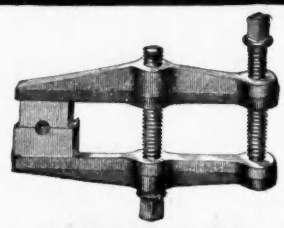

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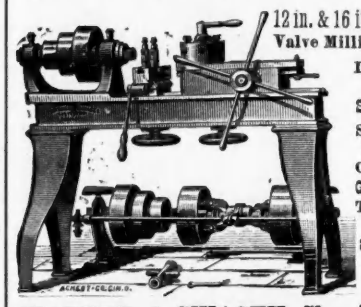

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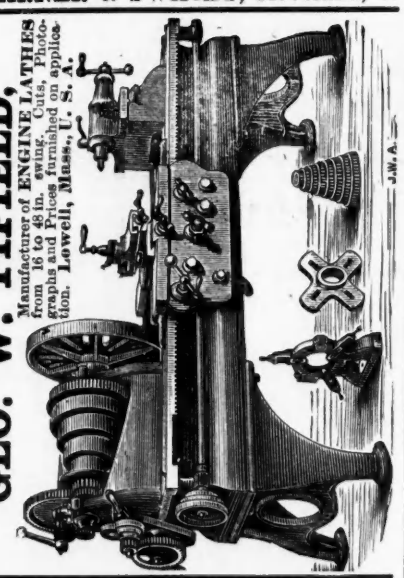

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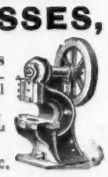

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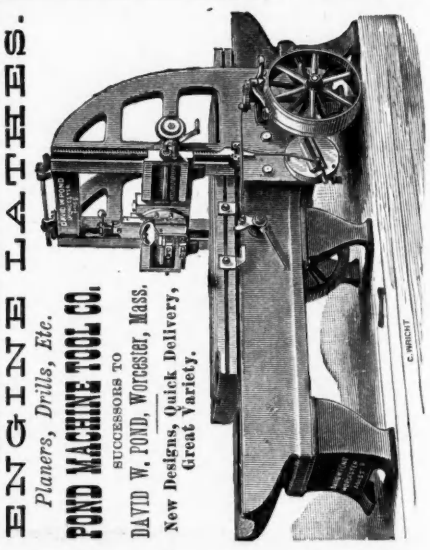

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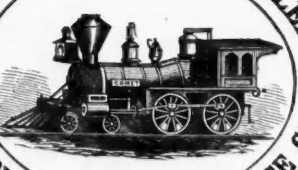

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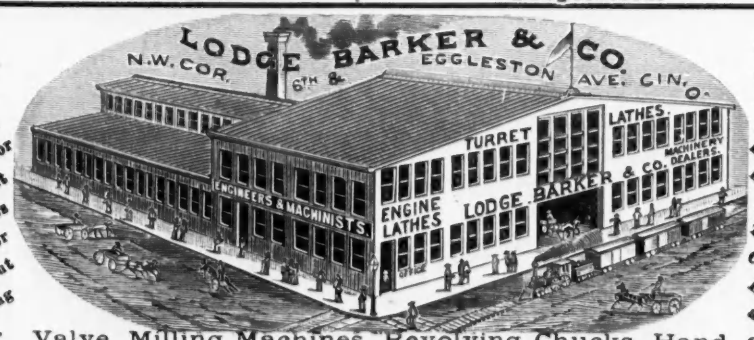

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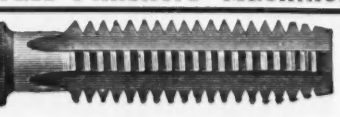

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